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Feeding The World: The Impact of Theo Brown and John Deere

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Table of Contents

1. Abstract

Throughout the history of civilization mankind has made farming its primary food source. In the late 1700s, British Economist Malthus predicted that population would outgrow man's ability to produce food. However with the vast technological advancements within the agricultural industry, the efficiency of farmers has greatly increased, thus allowing mankind to keep up with the growing population. Hard data will be used to show the change in population overtime as well as the overall food production in the United States over the past one hundred years.

This paper looks at how agricultural technology changed and advanced during the first half of the 20th Century. The primary method of study was through the diaries of Theophilus Brown, an engineer who worked for John Deere during this time. These diaries contained accounts of daily work as well as personal life displayed through text, sketches and pictures. Within the diaries, there is a vast well of first-hand information on the advancement of agricultural technology, both Theo's and his competitors.

Using the diaries along with supplementary historical references, this paper will look at how Theo Brown and John Deere affected the agricultural industry and therefore mankind as a whole. The team will look at the major innovations and projects of Theo Brown and John Deere to see how those affected the industry.

2. Acknowledgments

We would like to thank a number of people, without whom this project would not have been possible: first, to the gracious generosity of Theo Brown's family by making his diaries available to the Institute, and to us, upon which this whole project so heavily relied; to the staff of the George C. Gordon Library, especially Rodney Obien and Lora Brueck, who worked with us to ensure the availability of the diaries and any other resources that we desired; to all the people at John Deere, including Klaus Hoehn and Bruce Boardman, for providing us with such a wonderful opportunity to share our story and letting us get a glimpse of where Deere has progressed to today; to Roy Harrington, long time employee at Deere who has spent his retirement delving into the history of the company and was so eager to share his personal experiences with us, in addition to information he had discovered in his research; to Thomas Lynch, whose input assisted in telling the story and whose financial assistance facilitated our direct interactions with John Deere; and to our advisors, Professors Diran Apelian and Richard Sisson, who spent countless hours directing our efforts and advocating the our project, both within the WPI community and outside.

3. Introduction

Feeding the world has long been a concern of humanity, one that draws much attention and thought. In 1798 Thomas Malthus, a British Economist, released an essay which voiced, among other things, a concern about food production not being able to keep up with the exponentially growing population. Just over 200 years later we have the data to confirm this exponential growth, yet we are still able to produce enough food to feed ourselves. This must mean that there have been some very significant changes to the way we produce food. Advancements in agricultural technology made it possible for a small group of farmers to grow enough food to feed a much larger group of people. It was through the competition and innovation of many engineers and businessmen throughout the industry that spawned these advancements and pushed them to become industry standards.

For our project, we will focus on the engineer and how the engineer can bring these technological advancements into the marketplace. But first we must look at what qualities define a successful engineer. An engineer must communicate with his peers effectively; be knowledgeable in the latest state of the art technologies; be able to easily identify the causes of malfunctions in designs; be able to creatively find ways of improving them; and, above all else, have the customer in mind when inventing or modifying any new or existing device. It is also important that the company for whom the engineer works has certain qualities in order to create an environment that encourages and allows the successful engineer to unleash his full potential. The company must put quality and consistency in their product above all else and be dedicated to inventing new technologies to put themselves ahead of their competition.

We will show that Theophilus Brown and John Deere both had these qualities by exploring the diaries of Theo Brown, an engineer for John Deere & Co., currently the world's largest manufacturer of agricultural technology. The diaries recorded his thoughts and feelings on many issues that were important to him primarily his family and his work at Deere. After Theo's death the diaries were donated to Worcester Polytechnic Institute in Worcester, MA where they now reside in the archives room of the George C. Gordon library. There are sixty-three volumes in the collection. Theo kept a diary every year from 1911 through 1971, with two other diaries from 1893 and 1897. Figure 1 shows a few of Theo's diaries, they are leather bound and many have his name printed on the covers.

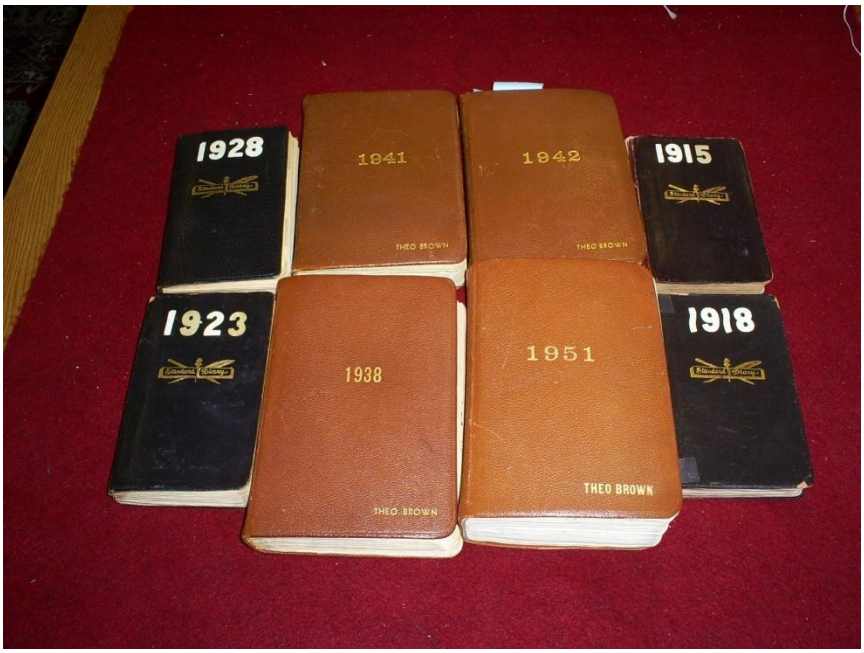


Figure 1: Sample of Theo's actual diaries

In many of the daily entries, he includes various information, such as information about the weather and names of people whom he and his family ate dinner with that night. Theo pasted into his diaries the ticket stubs from his trips by train and, beginning in 1950, occasionally by

airplane. He attached stamps from his stamp collection, along with pamphlets and brochures from places he visited in his travels. On many occasions when Theo drove long distances he affixed the map that he used to find his way. When he watched a tractor being tested in the field he got the signatures of everyone else in the field. He also got signatures of his fellow hikers in the Blackhawk hiking club whenever they went hiking. Mostly, he attached photographs of important happenings of the day, be it work or personal.

Theo was a fair photographer and took pictures of many of the things he encountered in his life. He used his camera for both work and play, on many days photos of tractors he tested in the field are side by side with pictures of his family. Whenever he went hiking with the Blackhawk hiking club or on vacation he took photos of people walking on the trail or of views he found interesting. Figure 2 below shows a photograph Theo took on one of his vacations; it shows Mount Washington in New Hampshire from one of his annual vacations. Figure 3 shows Theo riding a tractor in the field and is typical of the photos Theo took while at Deere. Theo's photography at Deere consisted of whole tractors and tractor parts that he designed and which he often made sketched days earlier in the diaries.

Figure 2: Lake in the Clouds on Mt. Washington

Although Theo's diaries span most of his life, we will focus on those during his career at Deere beginning in 1911 and ending in 1952. Through this unique perspective through the eyes of one man we will be able to see what he and John Deere contributed to the agricultural industry. In order to show such contribution we will describe in detail various major projects that Theo worked on throughout his career at Deere and Co. This will allow us to explain how his work on these projects affected the advancement of agricultural technology and therefore humanities ability to feed itself.

4. Background

Producing and foraging for food for the sustenance of civilizations has been addressed for many millennia. Hunter-gatherer tribes migrated with moving herds in order to sustain themselves. With the advent of farming technology, especially as implemented in the Fertile Crescent in ancient Mesopotamia and the flood plains of the Nile River in Egypt, civilizations began the process by which humans need not follow the migratory patterns of the beasts of the field. Over many centuries, agrarian based societies progressed to Feudal Europe during the Middle Ages and to Serfdom of czarist Russia. Historically, famines have plagued various regions with a variety of causes, most often caused by political strife, such as the Irish Potato Famine and famine of Central Africa. However, there have been times in which catastrophic crop failures wreaked havoc upon people; namely in Europe 1769-1774, early 1790s and 1837-1839.[1]

During this time, the British economist Rev. Thomas R. Malthus, most likely compelled by massive acute shortages, cited in 1798, "the constant tendency in all animated life to increase beyond the nourishment prepared for it."[2] He argues that over time, the cause of these historic famines would change to problems with diminishing supply chains stemming from the inability of farmers to produce requisite quantities of food. He continues on to explain that population grows at a geometric rate, while owing to diminishing returns, production of food might only grow at a linear rate.[3] Rev. Malthus showed that in the early United States, population growth closely approximated the exponential growth, at a rate of approximately 35% every ten years.[4]

Given this population growth rate combined with Rev. Malthus' theory of diminishing returns, according to his hypothesis, in a period of two centuries, whereas world population would have grown by a factor of 256, crop production would only grow by a factor of 9.[5] If current trends

had continued, the recently occurred famines of Europe would become embattled in a prolonged, epic battle with famine, the likes of which could only be likened to the Black Plague.

One may look at the work at Malthus and ask, "How are we still alive?" Initial thoughts should probe the validity of his facts. An examination of the world population and that of the United States over two century provides data as shown in Figure 1, which substantiates the exponential

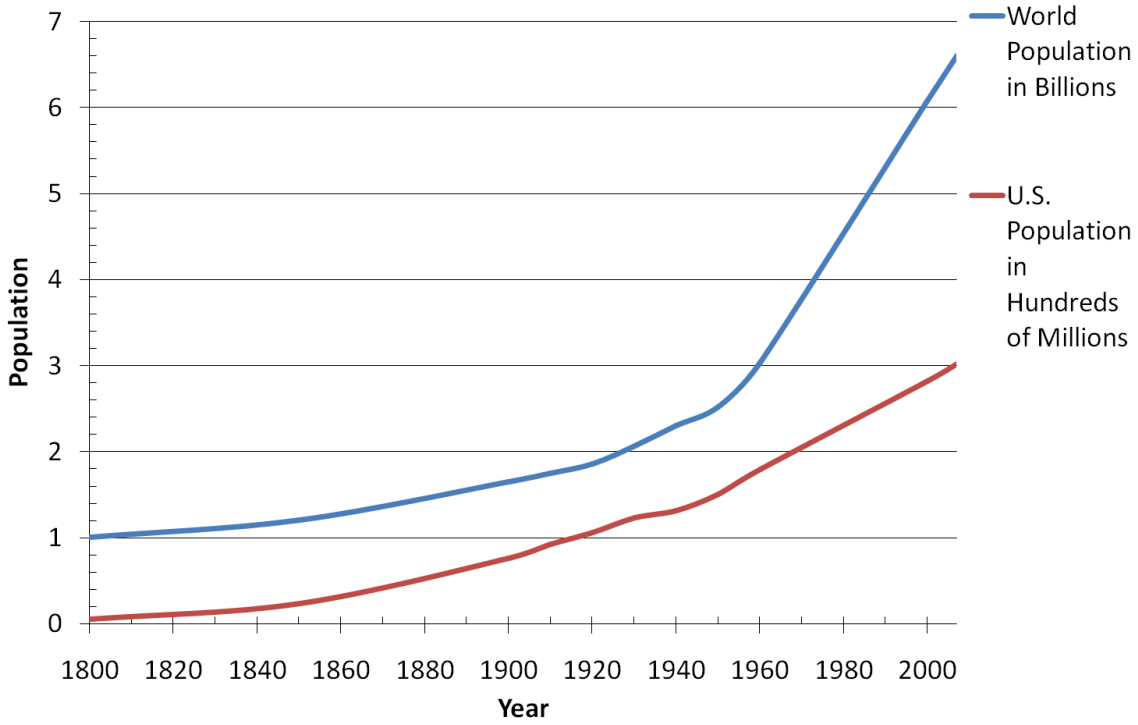


Figure 3: World and U.S. Population vs. time, 1800 - present

growth predicted by Malthus.[6-14] Resultant of this information, we must then consider another element of his hypothesis: the law of diminishing returns.

Malthus stated that, mostly as a result of the cultivation of less fertile soil, similar effort would yield fewer crops. Where the first acre planted might produce thirty bushels of grain, the second acre of seed may only yield 25 bushels, and so forth. This said, it would be understood that for each additional farmer laboring, smaller increases in output would occur. This effect would lead

to the starvation. Consequently, some have attempted to increase the individual farmer's productivity.

Until the Industrial Revolution, much of the world was agrarian based with a few, select merchant towns to facilitate trade, which mostly benefited the upper and upper middle classes. Cities such as Venice, Italy and Portsmouth, England served as trading meccas, in these cases, to the rest of Europe and beyond. With the advent of the Industrial Revolution, populations became more centralized as families moved from rural farmland to urban cities. This shift placed another strain on the already taxed agrarian developer, who had long since been upgraded from status of meager, self-sufficient farmer, now was burdened to create a greater quantity of food for a greater variety of non-farmers, such as the multitude of factory workers, merchants and the infrastructure taken for granted today within the city. As such, each farmer's net output needed to increase to accommodate the increased demand per farmer. One manner in which productivity was increased in 18th century Europe was through the introduction of the potato, which could easily grow in sub-standard soil, thereby increasing the possible acreage for growing crops, increasing overall yields.[15]

Innovators have sought to positively affect the output of farmers. Over the past two centuries, farming technology has grown with many new innovations: from John Deere's initial introduction of the smooth-sided plow, internal combustion engine tractors (both gasoline and diesel), affixing of rubber tires to tractor wheels and the introduction of the first self-propelled combine. Tractor innovation led to more common use of the hydrocarbon-fed monsters, and in 1954, the number of tractors on American farms surpassed the number of beasts of burden.

John Deere & Co has its roots in New England. Founder John Deere was born in Rutland, Vermont on February 7, 1804. He was raised in Middlebury, Vermont and apprenticed as a blacksmith. He became a Journeyman Blacksmith in Vermont and travelled around the countryside contracting with locals in need. Deere eventually set up his own blacksmith shop in Vermont. However, in the mid 1830's due to hard times economically he was forced to close up shop. Deere had gone bankrupt and faced a choice, deal with bankruptcy in Vermont or move out west, to the frontier and set up a new life for himself. Deere moved to Grand Detour, Illinois in 1836 and very quickly setup a new blacksmith shop. However, at the time Deere was unable to afford to bring his family with him, so he moved out alone and set up his shop. After establishing himself as a blacksmith in Illinois, a year later he returned to Vermont to settle his debt and move his family to Illinois. Deere spent most of his time repairing broken farm equipment. In 1837, Deere made a smooth-sided steel plow from a broken saw blade which did not get stuck in the sticky soil. Deere's new plow design worked well on the fertile lands of the Midwest and soon became very popular amongst farmers.

Once Deere had seen the need for this new plow he began manufacturing large quantities of them. Contrary to normal blacksmith practice of the day, Deere began manufacturing a large number of plows and would then take them around and sell them to farmers.[16] Over the years Deere consistently improved his designs and used the best materials available for his plows. In 1886, Deere's son, Charles, was elected Vice President of the company. [17] Charles Deere was a much better businessman than his father and eventually succeeded him as president of the company. By the time he passed away in 1907, Deere had expanded into producing other farm equipment, such as cultivators and corn planters.

In 1908 Deere bought the Marseilles Manufacturing Company. Deere began expanding its farm implement business, and in 1918 purchased the Waterloo Gasoline Traction Company. Deere had been attempting to develop a tractor on its own, but after numerous failed attempts, bought out the Waterloo Company and marketed the Waterloo Boy Tractor under the John Deere name. This is an extremely important moment in John Deere's history because it marks the beginning of their tractor development program. In 1928 Charles Deere Wiman took over the company. Deere had become such a strong company that even during the depression, when most companies were struggling or closing up shop, Deere was a highly profitable company with the exception of two years. Deere's devotion to engineering and innovation proved to be a highly successful business plan and led to Deere's strong product line and sales. By Wiman's Death in 1955 Deere was one of the major manufacturing companies in the United States. John Deere continued its devotion to engineering and making the best possible product and, in 1963, Deere became the largest producer of farm equipment in the world.[18]

John Deere is a world leader in its field. As a world leader it is important to examine what kind of environment led to its development and success. Theo's diaries detail a few specific happenings in the early 1900's that set Deere & Co apart from the rest. The engineers at Deere spent a significant amount of time in the fields developing products. All of Deere's products were thoroughly tested for faults to ensure that the best possible product be shipped to the customer. Many of Deere's innovation's came from this process. Many times Deere would compare its newest products to its competitors' products in the field and only after extensive testing and complete confidence that their product is superior in every possible way would Deere launch the product. Frequently, the current CEO would join these field tests, showing a genuine interest in product development and fostering of personal relationships with the engineers. It is

apparent that there are many friendships and encouraged communication between all the departments at Deere & Co.

Deere has demonstrated a strong commitment to its employees. Some of the most telling stories of Deere's commitment to its employees and commitment to excellence came when the company was doing poorly, such as during the Agriculture recession in the early 1920s and the Great Depression of the 1930s. In March of 1921, Theo stated in his diary, "Business was never so quiet as it is now."However, instead of laying off its valued engineers, Deere offered to retain its workforce by offering a voluntary "cut in all salaries of 10% up to $3,000 and 20% on all more than $3,000." Once business picked up again, in 1922, Deere made a lump sum payment to all the employees who took the pay cut. During the Depression, Deere, unlike most companies, managed to continue to be a profitable business, with the exception of 2 years, 1932 and 1933. During those two years though, Deere suffered. Even though the company was losing money, it continued to invest in the experimental department. Theo noted on September 19, 1931, "Business is nil and it is very depressing. We can keep busy in the experimental department."Deere held fast to its dedication to innovation and it was this devotion to engineering the best product possible that pulled them through the hard times.

One of the more influential engineers of John Deere during the first half of the 20th century was Theophilus Brown or Theo, as he preferred to be called. Theo Brown was born 1879 in Worcester, MA. He graduated in 1901 from WPI with a degree in Mechanical Engineering. As brilliant of an engineer as Theo was, which will be discussed at length later in this report, He was not that great of a student. In fact, he was a below average student in most of his classes. There

is a strong indication that Theo got bored in some classes, this explains why he received that wide variety of grades while studying at WPI.

After graduation Theo began working for a Worcester, Massachusetts based company, Richardson Manufacturing Co. After a business Trip, Theo was offered a job at the Marseilles Company. In 1912, Theo became the superintendent of the Marseilles Company. The Marseilles Company was bought by John Deere and later became the John Deere Spreader Works. In 1916, Theo was promoted from his superintendent position to head of Deere's Plow works experimental division. In April of 1918 Theo and other Deere engineers met with Henry Ford to discuss ideas and implements for the Deere plow and Ford's tractor. From there Theo became involved in many projects, most important of which is Deere's tractor program. Theo remained chief engineer of the experimental division for his entire career at Deere. Theo was also a Board member at Deere & Co for 30 years, until he retired in 1952. Theo maintained his diaries up until a few months before his death, in July 1971.

Theo was a brilliant engineer, but what kind of person was he? Theo was a respectful, dedicated person, a true gentleman in every aspect of the word. First and foremost, Theo was a Family Man. For all his engineering talents and aspirations, he was a loving, dedicated and loyal husband, father and son. It is very evident through his diaries that Theo cared greatly for his family. For instance, when his mother travels, he has her detailed travel plans written down. On May 8, 1931, his mother departed to go back to Worcester after spending time with him in Illinois. He notes that her departure time from Davenport, and arrival, down to the minute in Worcester. Theo married Elise Koehler in 1913. After Marrying Elise, Theo and Elise moved into a house in Moline, Illinois. They had two children: Elise (whom Theo often called Lee) and

William. Theo's son William severed in the U.S. Army during World War 2. Theo had always taken great interest in world events, but after his son joined the army he paid particularly close attention to the events of the world. Theo would copy the front page of a major newspaper into his diary almost every day of the war. He would draw maps from the newspaper showing troop movements as well as copy down all headlines and text from various stories of interest.

Theo loved the outdoors. He and Elise were members of the Black Hawk Hiking club in Moline, Illinois, where they would take hikes almost every Saturday. They would also frequently take walks together or with their children. During his annual vacations to New England, he would always take at least one major hike. Some of the hikes were at destinations such as Mt. Washington, Crawford Notch, and other popular places.

One of the most striking things about Theo is his skill as an artist. This artistic ability helped not only with his hobby sketches, but also with his drawings for work. A selection of Theo's sketch's can be found in Appendix A.

It is clear that Theo was a visual person; but what kind of engineer was he? He was an ingenious, creative and inspiring engineer. Theo was extremely well regarded in the engineering community. In 1935, he was unanimously selected to receive the McCormick Award from the American Society of Agricultural Engineers. Robert Trullinger, a close friend and A.S.A.E. committee member, cited that "It was the irresistible acclaim of the many men who love and respect you as an engineer, a gentleman and a friend." In a later conversation with Trullinger, Theo was informed that he "was wanted for President of ASAE and [Trullinger] was on both nominating committee and medal committee. He felt the medal was by far the greater honor.

5. Societal Impact of Theo Brown and John Deere

Theo was also given praise by the head of the company. In November of 1937 Charlie Wiman, CEO of John Deere at the time, said that Theo was "Top's in experimental work" (November 2, 1937). Eight years later Mr. Wiman was still of the same mind. In his diary Theo writes "he didn't want me to ever resign." His work even impressed John Deere's Competitor, International Harvester. Over breakfast on January 22 of 1945 Theo found out that International Harvester was more afraid of him than any man at Deere & co. While visiting the International Harvester patent office in 1939 Theo was told that "[He] was known in their office not as Theophilus Brown but as The Awefulest Brown."(1939) While this may come across as insulting it showed that International Harvester was taking notice of his work, and knew that Theo was a major reason for Deere being so competitive to their company.

As a designer Theo was involved in a project from conception to implementation. He cared that the project got done correctly. In 1928, when asked to complete a project on a tight schedule Theo said "We must do things right and then fast, but right first." He also is always trying to think about and predict problems that might come up. All these traits can be seen in his work and his writings in his diaries. To show this and also show Theo's impact on the world of agriculture we have chosen a number of different projects to discuss, the First of these being the Power Lift.

5.1 Technical Innovations

A. The Power Lift

Once of the biggest inventions for the tractor to come out of John Deer was the Power lift. This was a device which would raise and lower various implements such as plows, cultivators, and buckets. While the device itself was very simple, the impact it had was astounding.

"A works Progress Administration (WPA) study concluded that this one invention saved each farmer 30 minutes every day because operators could pull a lever from their sat, rather than get off the tractor to raise of lower the implement by hand. The WPA suggested that the power lift might have saved a total of 1,000,000 man-hours a year!"[19]

The Power lift was first devised in 1922 as a way to make raising a horse drawn plow out of the ground easier. Before this pulling the plow up was done purely by hand and required significant effort. As shown in Figure 4 this design allowed the farmer to simply press a foot lever and allow the plow to pull itself out. The device worked in the following way:

"To lift press on Foot lever, A is revolved by plow being anchored in ground about ¼ revolution. When plow has run itself out of ground A finishes its half revolution and plows, is locked out of ground by spring B. When foot lever is again worked the spring B revolves A until the spring has lost its pressure. Then weight of front end causes beams to drop until points of shares strike ground. The plow sucks itself in and A is locked" (Brown, 1/12/1922)

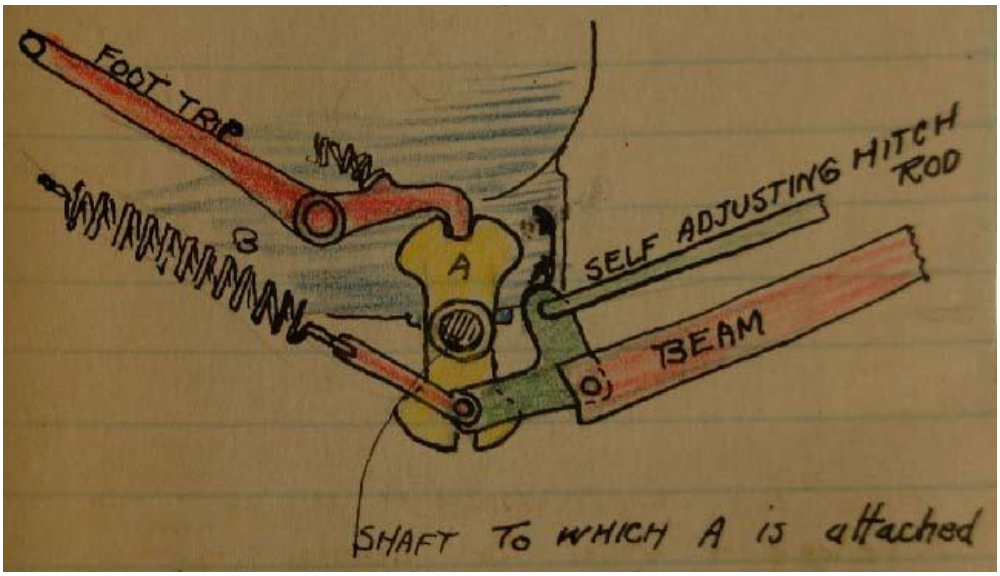


Figure 4: Mechanism for Lifting a Plow Out of the Ground

Taking this idea Theo Brown started to adapt it to the tractor in the later 1920's with the first production version appearing in 1928 on the Model D tractor which became the GP tractor after a very short while.

The Power Lift was designed to run off the Power Take-off, which was invented in 1919 by International Harvester and then standardized. The power take-off is essentially a second drive shaft, a powered shaft being driven by the engine that can be used to power various attachments. It was clutched and could be stopped and started as needed. Using this, the tractor could deliver power to things like combines, spreaders, seeders, and various other equipment. The intent was for attachments to have the ability to be attached and removed fairly easily and quickly. This development was so helpful and successful it was standardized and is still in use today. While you can still find physical shaft power take-offs on modern tractors it is more common to find them in the form of hydraulics.

Figure 5 from 1929 shows the fist design that went into production on the GP tractor. The PTO shaft had a worm gear, a design that Theo would come back to, which would drive a set of gears. When either of 2 clutches was engaged the lift would drive in one direction or the other. While this design had problems it was a start and gave Theo somewhere to go.

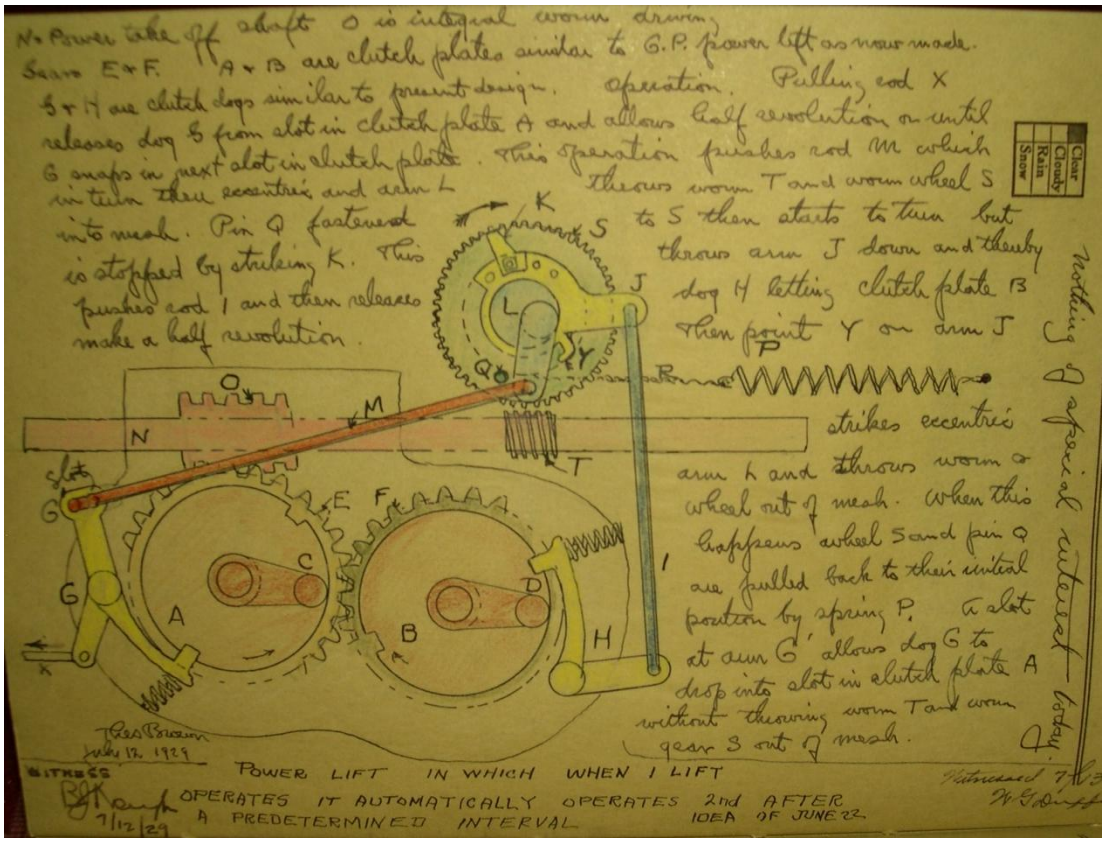


Figure 5: 7/09/1929 First Power Lift System

In Figure 6 from 1930 we see Theo's first sketches of a hydraulic power lift. While this idea was an improvement over the initial gears and levers it took a while to work through the challenges of the design. Theo spent the next year developing and advancing the hydraulics. The initial designs had problems with power and reliability. By January of 1931 the power lift was adapted to the cultivator. By doing this the farmer no longer had to get off the tractor after every row and

pick it up to allow the tractor to turn around. The power lift would allow the farmer to lift the cultivator from his seat with little effort.

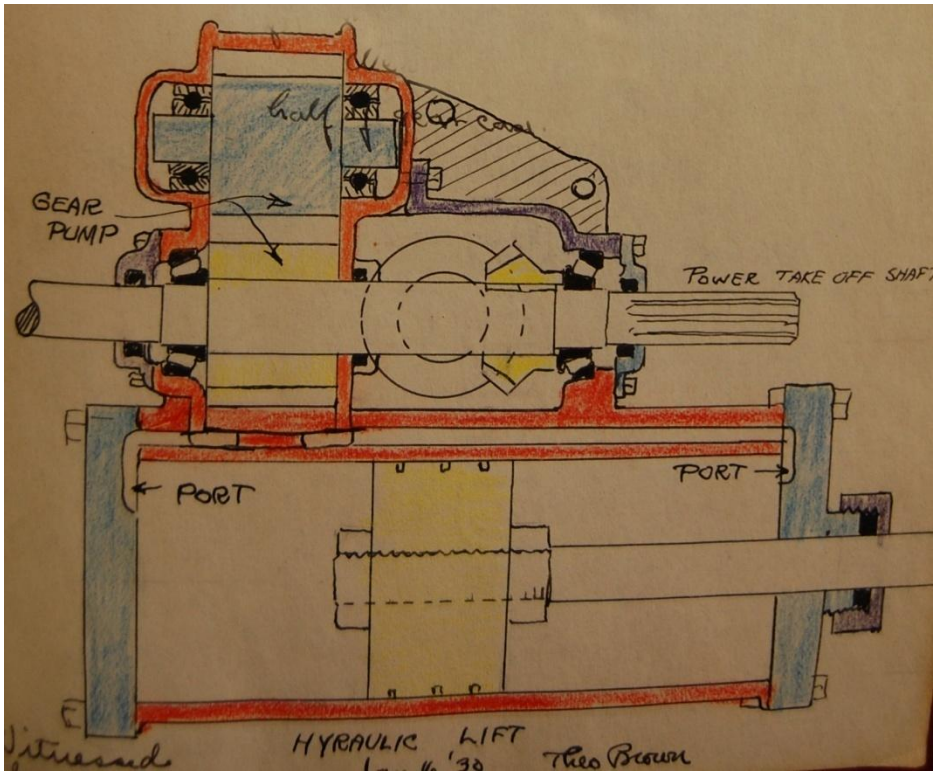


Figure 6: 1/15/30 Hydraulic Power Lift Design

By March of 1931 field testing was going well and the Hydraulics looked to be working well. By the end of the year the casing had been redesigned and internals improved once again, receiving board approval in October. By February of 1932 the Power lift looked like the sketch in Figure 7.

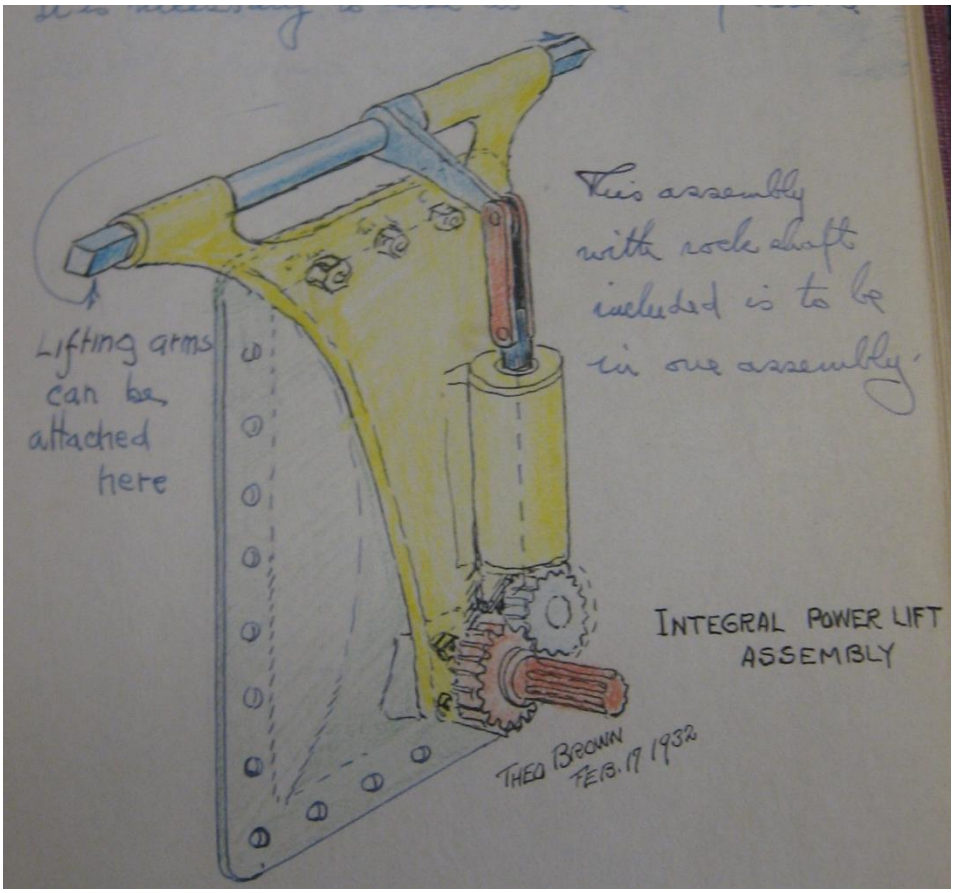


Figure 7: 2/16/32 Power Lift Assembly

Over the next year Theo started to change the design drastically. The hydraulics were replaced by a rocker bar and ratchet system which was driven by gearing off the PTO in an attempt to simplify the design. This was then upgraded to a double ratchet to allow the Power Lift to continuously raise or lower. The design was then changed again, this time in how the PTO drove the system. After the initial design in 1929 Theo changed to conventional round gears because of problems he had with the worm gear. The problem with this style gearing is that they can be back driven. This means that if you are holding a heavy piece of equipment in the air with the power lift it is trying to back drive the PTO shaft, putting unnecessary strain on the system.

While this was only a problem when the power lift was engaged, and not when it was locked and stationary, it still presented problems while the lift was being used.

To get around this problem the gear on the PTO shaft was changed back to a worm gear. The benefit of worm gears is that they can only be driven by the worm gear itself; the round gear cannot back drive the system. This new gearing system required no hydraulics or ratchets. The gearing drove a linkage that turned the power lift shaft. All this gearing was encased in oil to keep it lubricated. While this new design was far improved over old designs it was not without fault. It took Theo and his team months to work out the worm gear. Due to the design the gears wouldn't align properly and they would get grinding and jamming. Eventually though this was solved and high grade gears were used to ensure long life. This final design is shown in Figure 8 where we can see the PTO shaft coming through the casing and the linkage that drove the power lift shaft.

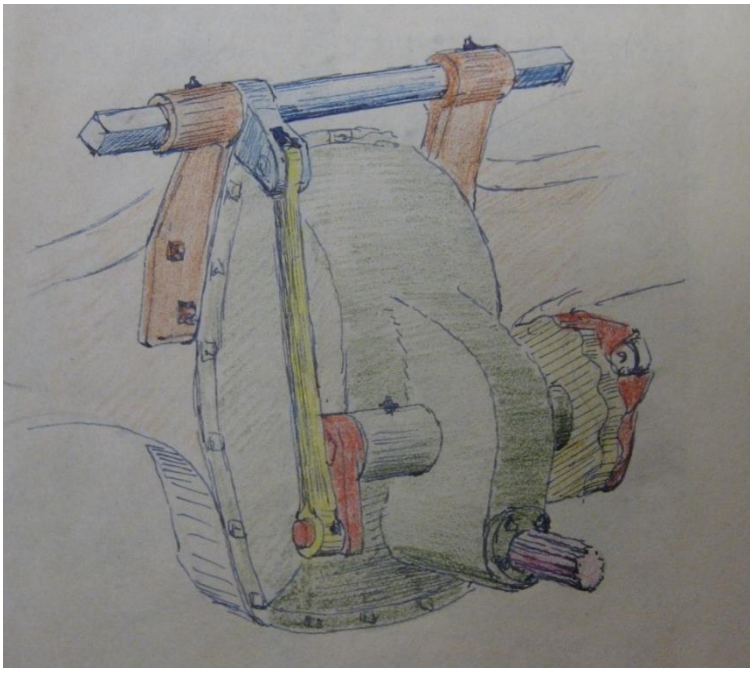


Figure 8: 5/9/33 Power Lift

Over the years following 1933 the power lift itself remained primarily the same, although convenience items were added. These included trip peddles and differential peddles. What continuously changed was the precision of the lift. As it was improved so was the accuracy. This allowed better control over the equipment it was controlling. This greater accuracy helped farmers yield better crops.

The power lift was hailed as one of the 3 biggest developments of its decade. The other two were pneumatic tires and International Harvester's Farmall tractor, which some historians have claimed launched the industrial revolution in agriculture.[20] Up until this point all equipment being driven by the tractor had to be raised and lowered by hand, either through levers and cables or physically picking it up. By harnessing a preexisting power source in the PTO Theo was able to make the farmer's job much easier. Not only did this save the farmer's energy it saved time as

well, something that is very important to farmers. When trying to get all the land owned by the farmer cultivated and ready for planting time is crucial, so any time saved is a great help.

On April 18, 1939 Theo made note on one of his sketches, shown in Figure 9, that Deere was collecting $2.40 on every power lift that International Harvester was putting on its F-14 tractor, adjusting for inflation that is close to $40 today. This development was so successful that Deere's top competitor was putting it on their tractors. This was important because it showed a change in trends. For the better part of the early 20th century International Harvester was known as being ahead of John Deere, this marked a point where Deere started to pull ahead. In 1938 alone John Deere collected just over $11,000 in royalties from International Harvester on just the power lift. Total Royalties from 1938 from IHC total to $99,535.90.[21]

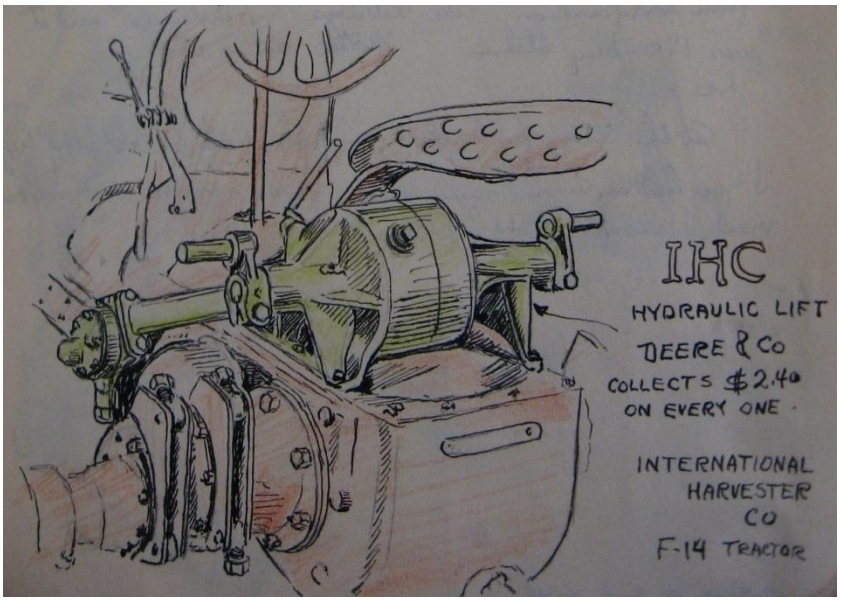


Figure 9: 4/18/39 Power Lift on F-14 Tractor

While you won't find this exact system on tractors today the idea is still there. Most modern tractors use hydraulics to power equipment. Using hydraulic pumps powered by the tractor

farmers can still adjust, lift and lower equipment from the comfort of the driver's seat. This idea was started with Theo Brown's Power Lift.

B. Adjustable Rear Wheels

With the start of the general Purpose tractor, many things were taken into consideration during the design process. One of these happened to be row spacing. Many farmers based their row widths off what had been established in the horse era. However different crops require different row widths. With this in mind Theo started work on adjustable wheel widths. The initial work was done on the front wheels, and then the focus was sent to the rear wheels leaving the tractor with a tricycle configuration.

By 1931 Deere had a tractor out that could have the rear wheels set to different lengths. The system was simple; the splined axle was longer than needed, so the wheels could be set to any length on the axle simply by sliding the wheel and bolting it in place. To gain more length variation the axles could be flipped. This system worked well, and was used in production tractors for many years. Where Theo ran into trouble was trying to make it mechanized.

In early 1931 we see his first sketch for a mechanized system, shown in Figure 10. This initial design was designed simply as a hydraulic pump that would push and pull on a lever, which in turn would push and pull the wheels in or out. By April of the same year a prototype was designed and in testing.

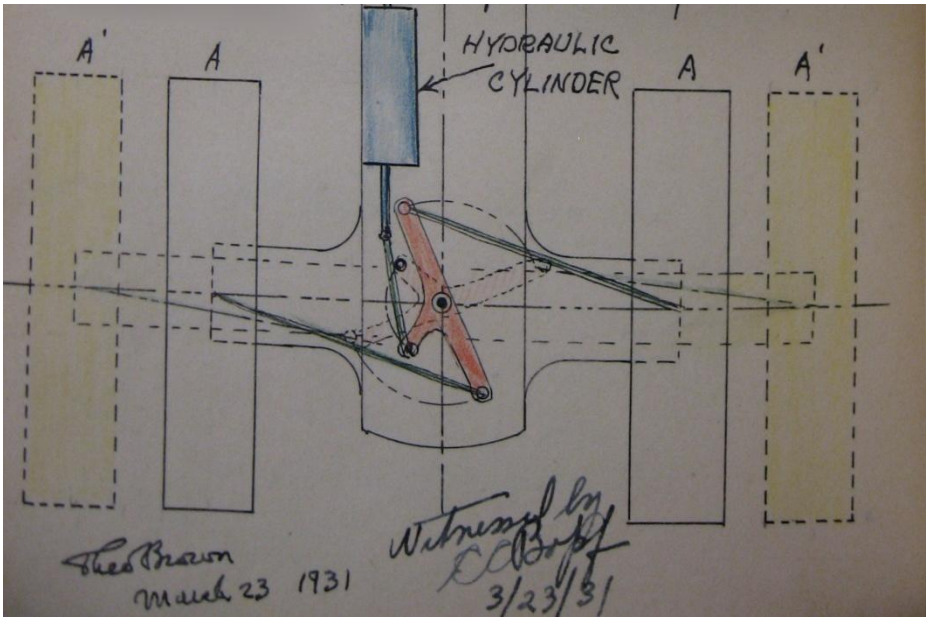


Figure 10: 3/23/31 Sketch of the Adjustable Rear Wheel System

The system went through many revisions over a number of years to try and improve and simplify the design. One such design involved no power source other than the tractors movement. Shown in Figure 11 we see a telescoping system set up on the axle. The farmer could set a stop at the width desired, Then while driving he pulled a lever which would lock one axle. While it was locked the wheel would still spin, however the wheel was spinning about the axle rather than with the axle. This rotation caused the telescoping device to screw the wheel in or out depending on tractor direction. While this telescoping idea was very clever in theory tests proved that it did not work well in practice.

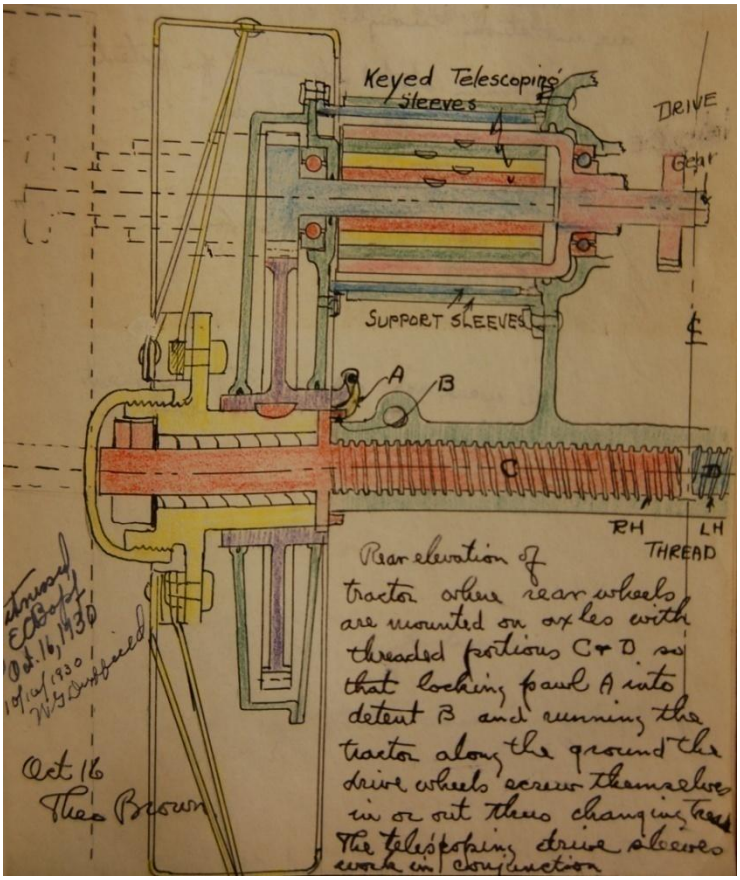


Figure 11: 10/16/30 Telescoping Wheel Width Adjustment System

In May of 1931 Theo adapted the system to run off the Power Lift discussed in the previous section. This adaptation utilized a rocker bar and ratchet system. As the Power Lift shaft turned it would operate this ratchet and push or pull the wheels in or out. As long as the tractor was moving or jacked the farmer could continuously adjust the width of the rear wheels.

This design was shown on May 15 to Charlie Wiman in the field and Theo says “I think both men were impressed.” This comment shows the interest that the company had in such a device.

While the system stayed primarily the same in principle, Theo and his team continued to advance the design through most of the 1930's. The final production design on the Model A had a range of 56-80 inches.

This final design is shown in Figure 12. Unfortunately due to complications the idea was dropped. The system was something that was greatly desired, and is still desired to this day, however due to the complexities of making such a system work reliably a solution has yet to be found. The tractor shown still exists, it was found in a barn a number of years ago and was bought by a private collector.

Figure 12: GP-Experimental Tractor[22]

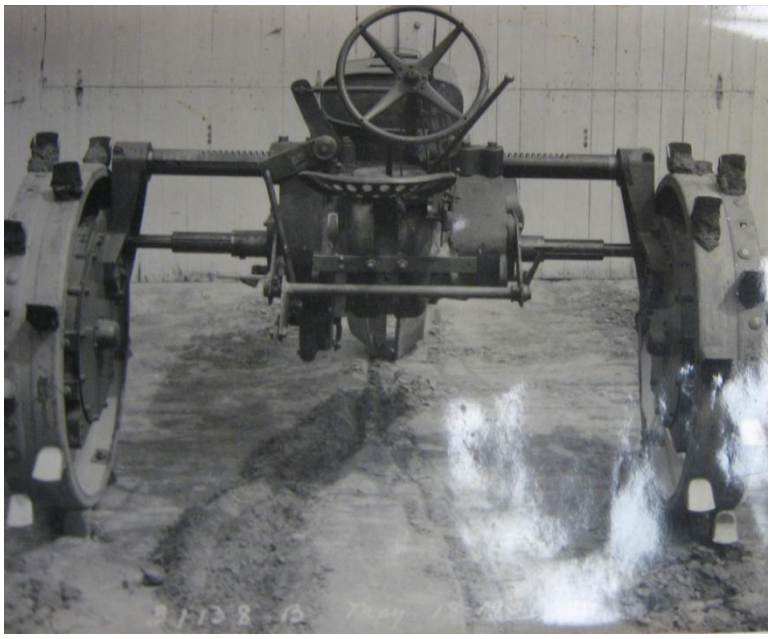


Figure 13: GP-Experimental Tractor with Wheels Extended

While this project didn't impact agriculture much in the sense that it never really made it to high production, it did help Deere. It showed that Deere was committed to trying to make the best product available. They saw a problem and tried to come up with a solution. In a way they did as the non-mechanized system has been implemented on various models through today. The ability to change the wheel width continues to be important to farms, and this system provides a solution, allowing farmers to use one tractor for various crops and tasks.

But while the non-mechanized version has had continued success, a mechanized version has not been implemented with much success by any tractor company. It remains problematic to make a system that can be mechanically adjusted on the fly and still take all the forces and stresses that come with the tractor. However this continued effort through the 1930's to make usable design proved to customers that Deere was trying to meet their needs.

C. Cultivators

At the beginning of each farming season, the ground needed to be loosened and stirred before it could be managed. Even after planting, cultivation would continue throughout the growing season. In the early 20th century, this process was done by means of a cultivator. Numerous shovels or spikes were connected to a single frame, which was attached and pushed by a tractor. These shovels would dig and drag through the ground breaking up the soil. Theo spent a great deal of time on these devices during the late 1920s, a time at which the efficiency of power cultivation took great strides.

Theo put his cultivators through the most grueling tests, before sending into production. One of the most important things in a cultivator is versatility. Conditions can vary from sandy to hard and dry, to muddy. The terrain can also vary from flat, to uneven, to steep hillsides. On Jan 12, 1928 after a day of testing Theo wrote, "very soft sandy loam cause the tractor to sink in very considerably.... Later we tried this cultivator for strength. In hard ground we gave the tractor all it could do. It certainly penetrates.... The rear rigs are hard to put on and it is our thought (McCray White & mine) that a combination hitch can be developed that will act as a support for draw bar, rigs, & planter."

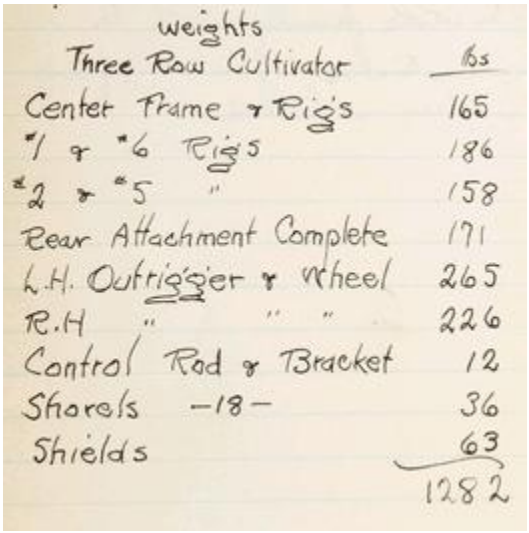
Theo took into account more than just performance and versatility. There were other considerations that were important to customers, such as cost, view (as in how well the operator could see everything), ease of attaching cultivator to the tractor, and its overall. "In field with 4 row cultivator of new type…. We were all favorably impressed. The penetration seemed good. View and ease of attaching not so good as others, but cost appearance and being close coupled are distinct advantages." (May 22, 1929)

Figure 14: 6/10/29 Testing in the Field

One of the most important aspects of power farming is efficiency. The amount of man hours required for each job is greatly reduced. One of the most time consuming issues with the cultivator was lifting and lowering the device. This had to be done manually, which was quite difficult due to the fact that it is a very heavy device, often upwards of one thousand pounds. This meant that every time the operator needed to turn around while cultivating, he would have to get off the tractor, lift up the device, get back on the tractor to turn it around, and finally get back off to re-lower the cultivator. Power lifts were implemented in the late 1920s allowing the farmer to simply push a lever in order to raise or lower the device. This meant that the cultivator was far more efficient than before. However with these changes, the cultivator needed to be redesigned.

In February 1928 the first power lift and tractor was undergoing final testing. However Theo found numerous issues with the previous cultivator design that did not work the same when used with the power lift. He and a coworker, Ted Johnson, compiled a long list of changes to be made. Some of these included drilling holes or machining grooves to provide oil, changing over to oil-less ball bearings, shield redesign, dimensional changes, and the use of different fasteners.[23] In Figure 15, Theo is working on reducing the weight of the cultivator. This is a necessary step in

the redesign of the cultivator to reduce the required force and durability of the power lift drive train. The lighter the cultivator, the more easily it can be lifted off the ground.



weights

Three Row Cultivator	lbs
Center Frame & Rig's	165
#1 & #6 Rig's	186
#2 & #5 "	158
Rear Attachment Complete	171
L.H. Outrigger & Wheel	265
R.H " " "	226
Control Rod & Bracket	12
Shovels -18-	36
Shields	63
	1282

Figure 15: Weight of various components on the three row cultivator

As Theo and the rest of the industry experimented with various different designs various problems would arise from any given design. Minor and major redesigns would need to be done to address these issues. The most common problems were structural failures, steering stability, and suspension stability.

The steering was one of the most difficult issues that Theo and the other engineers at John Deere had encountered. Poor cultivator designs might very unresponsive or unstable steering. A colleague of his created the steering mechanism seen in Figure 16. Theo tested the device and his initial thoughts were that it was not that much improved over the previous steering mechanism considering the increased cost of this new steering system.

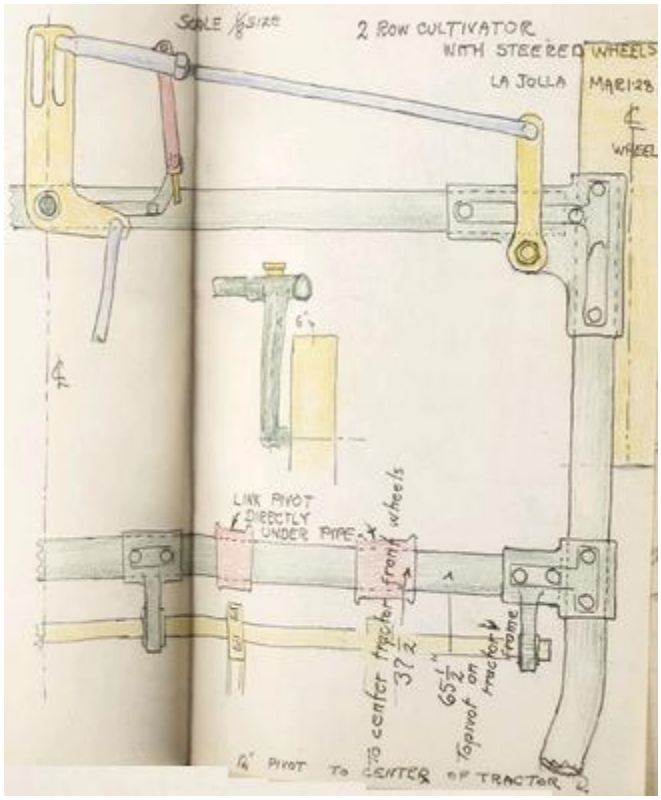


Figure 16: Steering mechanism

The suspension of the cultivator is another crucial aspect to the stability and consistency of its operation. After testing a four-row cultivator, Theo wrote of its issues. "Two defects showed up. 1. There is a tendency for the front wheels of tractor to lift. We must attach lower to tractor; possibly at draw bar holes." Essentially this is a statics problem. The force of the cultivator pushing against the ground causes the tractor to tip backwards. The hitch for the cultivator was too high off the ground, which created a large moment. If it was attached to the tractor at a lower point, then it would create less moment.

Theo was able to also solve more complex problems that may arise for special cases where standard assumptions no longer apply. In this particular case Theo tackles a problem where the cultivator is not digging into the ground evenly when the ground is uneven. His solution was to

completely remove the spring suspension since it was not allowing the cultivator to dig into the bottom of dips in the ground properly. This free suspension would be able to move freely applying a constant force to the ground allowing for even cultivation in uneven terrain. This suspension had a constant force because the only variable was the weight of the cultivator which in this case is constant. With a spring, the upward force would increase as the cultivator was lowered further and would decrease as the cultivator was raised.

However for even terrain conditions, there were certainly advantages to having a spring suspension. In Figure 17, Theo has designed a spring suspension that will greatly reduce the workload required from the power lift. On April 24, 1929, Theo writes "Total of 2400 lbs to be lifted on power lift thru distance of 6 in travel…. A 500 lb lifting spring on lifting rod would leave 1100 lb."

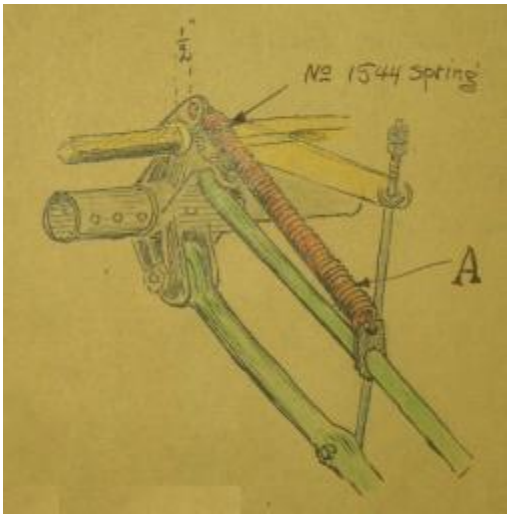


Figure 17: Spring Suspension setup

In late September Theo designs a very simple lightweight cultivator that is supported on its own wheels, Figure 18. On September 6, 1928, Theo writes, "It looks as this idea might work out to make a simpler, lighter, and cheaper cultivator." Upon testing the new cultivator Theo and his

colleagues discover that the steering and view were surprisingly good.[24] Based on Theo's comments after testing, it is implied that this is perhaps the best overall design for a cultivator that John Deere has seen to date. "We had the outfit built as a two row and everyone was much pleased at its ease of operation." (September 15, 1928)

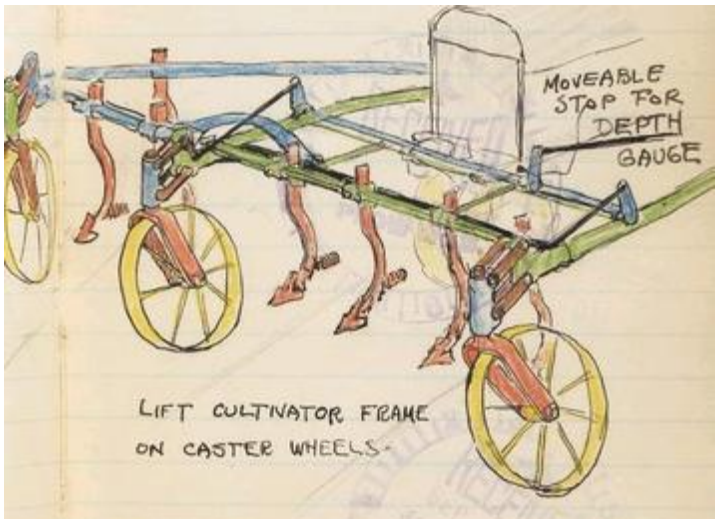


Figure 18: Cultivator with support wheels

Figure 19: Field Testing

D. Spreader

Fertilization has been an essential part of farming throughout the history of man. Without proper fertilization, farmlands would eventually lose its ability to yield high volumes of crops year after year. As power farming began to dominate the marketplace, farmers used spreaders that would evenly spread manure, lime, or other types of fertilizer at a rapid rate throughout their farmlands. In the early 1900s, spreaders consisted of a massive cart that held large volumes of fertilizer, a beater which would pulverize and cast the fertilizer onto the ground, and an apron which would regulate the amount of fertilizer being sent through the beater.

One particularly popular spreader to come out at the time was the low-down spreader. This was a different from the previous spreaders at the time, because the entire cart, including the sidewalls, was much lower to the ground. This meant that loading the spreader with fertilizer would be a much easier job. This was patented in 1910 by Spreader Works. During the time of this development Theo was the head of the Marseilles Manufacturing Company.

Once the Low-Down Spreader was on the marketplace, Theo would often address various problems and implement new improvements to the device to ensure that the new invention was the best product on the market. He would often receive reports of spreaders not working properly or breaking entirely. In response, he would always do his best to remedy the problem as quickly as possible.

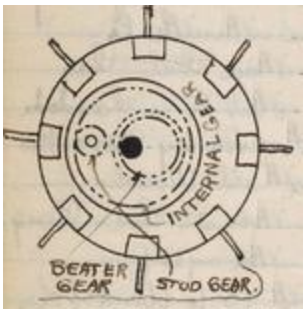
On October 10, 1911, Theo heard of a broken spreader in Syracuse and went down to inspect the device. After inspection, he discovered that an intermediate gear had broken. However he speculated that its cause was due to a stop device that was unexpectedly wedging the beater up

against the side of the spreader, causing excessive binding. The next day, a newly designed stopping device was put onto the spreader and it worked perfectly.

In early March Theo writes of a recurring problem with a disc gear in the lowdown spreader. "Low Down Spreader with disc gear given out again 3 times in all." (March 4, 1911) A few days later he rearranged the internal gear system to use a ratchet feed instead of a worm feed. The very next month, Theo signed a patent application for the ratchet feed on the low-down spreader. (Apr 8, 1911)

According to a textbook from the early 20th Century, *Agricultural Engineering*, by Davidson (1914), worm feeds are much better at regulating the speed of the beater, however if they are put under high loads, they will wear and break quite easily. Ratchet feeds do not break as easily, however they do not regulate the speed of the beater. If the beater is put under loads, then the ratchet feed will simply speed up instead of breaking. High loads often occur when the spreader is going uphill and the fertilizer slides up against the back of the spreader.

In late August of 1911, Theo came up with a new system for driving the beater. He wrote, "Thought of idea of having a beater eccentric with main axle of spreader & mounted on two eccentric [brislings] held from revolving on the axle and having an internal gear keyed to main axle and having a gear on beater head. By throwing the eccentric the gears can mesh through an intermediate stud gear. Showed it to Mr. Fowler who said it was a good point & one to patent immediately." (Aug 31, 1911)



About a week later he continued to discuss the issue with Mr. Fowler and came up with some additional ideas on how to avoid any conflictions with current patents on beaters. Theo wrote, "Spent most of the morning with Mr. Fowler in going over patent for eccentric beater. Thought of another way in order to avoid Love's patent that is to use a planetary gear transmission in which 3 sets of gears revolve around the gear cast on beater head." (Sep 6, 1911) The following day he shared his idea with Mr. Fowler who thought the idea to be brilliant. Theo wrote, "Went up to Mr. Fowlers'. He said that the last idea of eccentric beater was the best idea for a spreader that had ever been conceived." (Sep 7, 1911)

E. Tractors

Theo Brown's largest impact on both Deere and agriculture in general came through the tractors he designed. Theo's first big contribution came in the form of the GP tractor. The GP was released on June 28, 1928 by Deere.[25] It was meant to be a tractor which could be used for any crop on any type of ground. It was very versatile and was made even more effective with the inclusion of a power lift device, which was discussed earlier. This was the first time a power lift device, operated by a foot pedal, was used on a tractor in Deere's history.[26] The power lift device was what made the GP tractor special. The power lift device became standard on all tractors after the GP was introduced. However, Deere produced only 30,274 GP tractors from 1928 to 1935 making this model a relative failure.[27] The original GP tractors had problems with their steering;

the steering shaft the tractor used made steering on roads difficult. Theo Brown and Deere made adjustments and a year later came out with the GP-Wide-Tread tractor which was a clone of International Harvester's Farmall tractor.[28] The GP-Wide-Tread was no match for the Farmall and as a result the Deere GP did not sell well. Still, the GP was a pioneer tractor for later tractors like the Model A and Model B tractors.

Two tractors that were important to Deere were the Model A and Model B tractors. The Model A tractor was introduced in 1934 and production was continued to 1954. It boasted an adjustable rear axle which could space the rear wheels anywhere between 56 to 84 inches apart, increasing the steering capabilities of the tractor. This tractor was the upgrade to the GP and thus served the same capacity of being a versatile tractor for any crop on any type of land. The Model B tractor was a scaled down version of the Model A for farmers who did not need a large tractor. The Model B sold from 1935 to 1952and sold over 306,000 tractors over that time period.[29] Both the Model A and the Model B sold over an incredible time period, 20 years and 17 years respectively. These tractors were highly successful and were the mainstays of Deere from the early 1930's to the early 1950's. These were some of Theo Brown's more successful designs from a sales standpoint, but sales are not the only way to measure success as the 202 tractor showed.

Figure 20 (above) John Deere Model A Tractor[30]

Figure 21 (above) John Deere Model B Tractor[31]

In 1950 Theo came up with his initial design of what he would call the 202 tractor. This new tractor design was very different from any that Deere had come out with before. Instead of the driver sitting directly over the rear axle Theo moved the driver's seat a few feet forward of the rear axle. The reason for this move was so the driver could see how the implement they were using was performing. In the existing tractor models the rear wheels blocked the driver's view of side mounted implements. This was important because farmers did not have computers to tell

them how deep their plows were or the conditions of the ground. The 202 was also lauded for its handling by the people who tested it in the field. In his diary on February 16, 1950 Theo writes down a list of features for the 202 tractor, such as “unobstructed vision for operator, easy to mount and dismount, and no hot air blasts from motor in operators face”. These are just a few of the features that Theo wanted the 202 tractor to have.

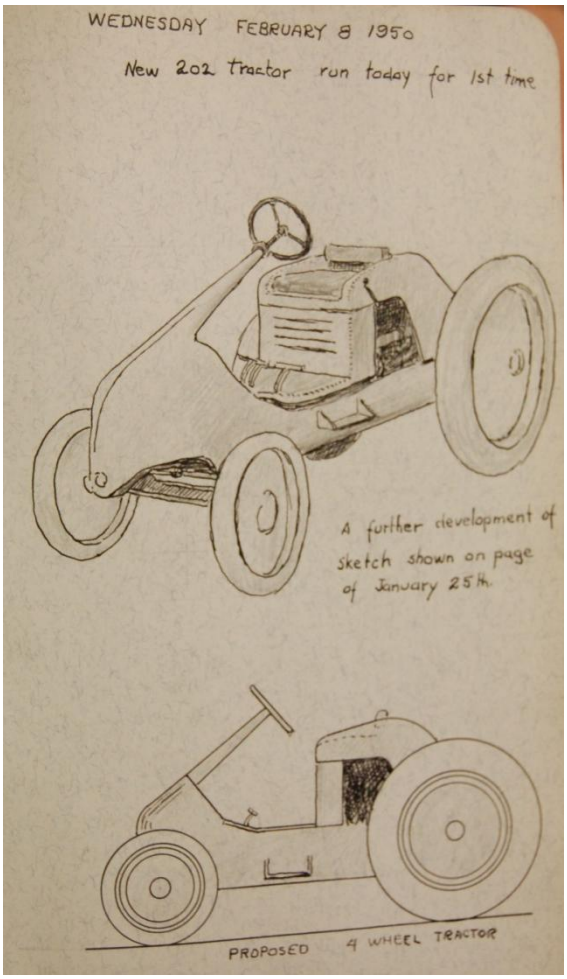


Figure 22: 2/8/50 The 202 Tractor Designed by Theo

A distinction should be made that the idea for the 202 tractor came from Theo Brown himself and no one else. He used his twenty plus years of experience designing tractors for Deere to design what he thought was a tractor of the future. On May 28, 1950 Theo writes, “I’m feeling

more relaxed then for a long time for it does now seem as this the #202 tractor which I thought out and built without any encouragement from Deere Co now is showing up remarkably in tests with its own integral implements is justifying my effort and work". The 202 tractor did not even make it into production, but the concept of positioning the driver's seat to allow maximum visibility of the implements is still around today. Even Theo Brown's unsuccessful projects still had an impact on how Deere Co. designed tractors.

F. Customer Satisfaction

Theo took great pride in customer satisfaction and making sure that the tractors he designed were exactly what the customer wanted. While Theo was part of the Experimental department of Deere this did not stop him from checking in on his designs after production to see how they were performing. Since Theo designed many of the products Deere sold he was often called upon to assist Deere customers if they had any problems with products they had bought. An example of this occurred on January 30, 1925 when Theo learned of a problem with the clutch of #40 plow in California. Over the next eleven days Theo redesigned the part to solve the problem and shipped it out. On February 11, 1925 he writes that he relieved a, ""Wire from San Francisco would seem to make trip to west unnecessary." Theo received notice of a problem and within twelve days had a replacement part designed, manufactured, and shipped out. This example exemplifies the type of service Theo Brown and Deere gave to its customers to insure their complete satisfaction.

This practice of dealing with any problems that a customer may have had after they bought the product helped Deere to keep those customers as well as create new ones. Customer satisfaction is an important part of any business because it gives the company a reputation. Theo Brown

helped Deere keep its reputation of always being ready to fix any problem related to Deere equipment. Deere could assure its customers that any problems they might have would be dealt with quickly and without much fuss. Customers who bought Deere products may not have known how to fix the equipment if it broke down. Knowing that someone would come and fix it if they had a problem gave people incentive to buy farm equipment from Deere. People who were assisted in this way might have become repeat customers or mentioned Deere to other people thus gaining Deere more customers. As mentioned before Theo was a part of this practice and so served Deere well in the realm of customer relations.

Another area of customer satisfaction that Theo took part involved using actual feedback from the potential customers. He often wrote about the importance of getting farmers' opinions of his designs. On June 6, 1950, after testing various tractors in the field Theo writes, "I suggested the outfits be loaned to good farmers so another viewpoint could be had." Theo wanted to loan the tractors to farmers and let them ride them around so that he could get their opinions of them. He would use their input to make changes so that his design will be more satisfactory to the customers. Theo never let himself think that he always knew what would work the best and valued the opinions of the people who he was designing the products for.

Customer satisfaction was and still is an important part of Deere business practices. Today Deere equipment can be very complex and the people who buy and use it rely on Deere Co. to fix any problem that may arise. The complexity of the machines almost requires that the customer have confidence in the company to come out and fix it if the equipment breaks down. Most farm equipment has always been a fairly large investment on the farmer's part and so knowing that Deere will fix it if it breaks down allows them to buy new tractors without worry. Theo was very

involved in keeping Deere's customers satisfied by fixing any problems they had with Deere equipment and by designing equipment to the customers' needs and wants.

5.2 Leadership: Individual and Corporate

John Deere, as a whole, has been one of the most successful companies in its field, outlasting even its greatest competitor from the first half of the 20th century, International Harvester. They have managed to expand their products to cover many areas offering machines to make many people's jobs easier and more efficient. Some of these areas include orchard work, industrial work, and personal equipment.

Arguably the largest section of Deere is the tractor works. John Deere did some experimenting with tractors early on with little success. The start to their popular tractors came with the purchase of Waterloo Boy in 1918. With this purchase came their popular gasoline engine. Deere continued to sell tractors under the Waterloo Boy name up until 1923. In the same year Deere released their model D tractor, which although it wasn't the first tractor to bear the Deere name, was the longest running production model.[32]

In the late 1920's Deere started the General Purpose Tractor. Made in several variants this was meant to be a smaller tractor than the D, designed for mostly the row farmers. The tractor came in various wheel configurations, including a standard front, tricycle set up, a wide tread variant and an orchard version. While this tractor should have done very well it turned out to not sell very well at all. Part of this was due to a poor decision to make a 3 row cultivator. This idea combined with the success that the IHC Farmall was having put a negative light on the GP.

To make up for the poor response to the GP Deere put out the model A in 1934 and the Model B in 1935. The Model B was slightly smaller than the A, but both were designed for essentially the same thing, row farmers. These were the first tractors to really challenge and compete with the Farmall. They were such a success that they were changed very little over their production life through the 1950's. As a result these 2 tractors were the most popular Deere tractors ever produced.

In 1937 a small Utility tractor called the Model L was created in the Wagon Works. This was the first tractor to have a vertically designed engine. This design was different from the Waterloo horizontal engines, and started the trend for later tractors such as the M. In the same year the Model G was put out as the big brother to the Model A.

The Model H was released in 1939 as a little brother to the Model B, designed for light tasks such as Cultivating. This design helped greatly in replacing horses on the farm. It was replaced in 1947 by the Model M which also had the vertical inline engine. In 1949 the Model R came out as Deere's first Diesel Tractor. This was an important tractor for Deere, signaling the start of the switch to Diesel, which is what just about all industrial tractors run on today.

Looking at this list it is interesting to see just how involved Theo was in the tractor business of Deere. While he wasn't working in the tractor works in Waterloo Iowa, he was head of the experimental department where most of the new ideas came out of. In particular the GP tractor was the work of Theo.

In 1925 Theo was given the task of designing a row work tractor. He started work on an experimental tractor which was eventually called the Model C, and then had its name changed to

the GP after a year. Aimed at competing with the IHC Farmall; this tractor was designed after observation of other tractors on the market, and was first released in 1928. Theo led the design and production of this new tractor, which unfortunately didn't do well in the market. The idea to have the tractor straddle one row while cultivating and use a 3 row cultivator ultimately lead to the downfall of the design.

In an attempt to save the tractor, and Deere's rank as second in the industry, the GP was redesigned to a tricycle configuration with a wide rear tread in 1929. This idea mimicked the IHC Farmall, and was received with much more praise than the early GP. Perhaps the greatest success of this tractor however was the Power Lift Discussed earlier. This device was used on various tractors following the GP and even on Competitors Tractors.

Following the end of the GP tractor Theo began to make observations that he was started to observe others ideas rather than present his own in the tractor department. He no longer was in charge of designing the tractors, but rather helped improve the new ones and make attachments for them. McCormick started to take over the tractor design, however Theo would make comments on ways to improve the tractors as well as field test them often. From this point forward most of Theo's work was based in the creation of plows, cultivators and other attachments.

In the 1940's Theo made one last attempt at tractor design. He came up with the 101 "All Visibility Tractor". This was a rear engine, front seated design that gave farmers visibility all around them. It was meant to be a small, single row cultivating machine. The idea never went into production as the look was too different from what Deere had been making and it was feared

that the product would fail. The model did receive praise from those that drive it, but it was never given the chance to succeed in the marketplace.

It is apparent then that Theo did play a large role in John Deere's tractors. From testing and help on the Model D, through his own last design he helped to shape the direction of the John Deere Tractor. Elements of his work can still be found on modern tractors, even if they are implemented in different ways.

A. Deere's Innovations

John Deere was one of the most influential farm equipment manufacturers in the 20th Century. Today they are currently the leading manufacturer of farming equipment worldwide and have been for about half a century. From their small beginnings as a small scale plow manufacturer, John Deere slowly worked its way into the industry starting by making farm implements for the Fordson Tractor. Eventually John Deere made its way into the tractor business itself and began designing farm equipment for its own tractors. By the 1920s, John Deere was second only to International Harvester in total farm equipment sales.

From power lifts to plows to cultivators to planters to tractors to combines, John Deere strived to make the best farming equipment on the market. By the late 1920s, John Deere was making top quality tractors. They introduced the first successful power lift on the market for their General Purpose tractor in the late 1920s. By the 1930s, John Deere perfected the system using hydraulics and high grade worm gears.

Deere tractor implements were also among the best. The cultivator was offered in two-row, three-row, and four-row. Along with their innovative power lift, John Deere's cultivators and

various other tractor implements quickly became among the top quality products of the industry, if not the best.

Theo Brown played a major role in the development of all of these products at some point during his forty years working for Deere Co. While he worked for Spreader Works, Theo Brown worked on the lowdown spreader, which was a great improvement over the traditional spreader that the industry had been using before. Though Theo Brown did not work on the initial development of the Power Lift, he did a lot of work on the device to improve it once it reached the marketplace. The first models of the power lift would wear out and break far too quickly. But as the years progress, Theo oversaw its development and drew up numerous redesigns on his own.

Theo spent most of the mid and late twenties working on cultivators. By the end of the 1920s, Theo had overseen the progression from two-row cultivators to four-row cultivators and fixed many issues with large cultivators such as poor steering. During this time, Theo also oversaw the development of the John Deere tractor. He was very familiar with these machines and would often make minor changes to the basic design in order to fix common failures or malfunctions. By the late 1930s, Theo had designed several tractors that were used for a number of years without major changes to his basic design.

B. Deere Today

Today John Deere Co. is the largest manufacturer of agricultural equipment in the world. They have factories and distribution centers located all over the world on six continents. In 2007 Deere recorded $24.1 billion in revenues and $1.82 billion in total net sales.[33] These earnings are built on Deere's current employees as well as those who came before them like Theo Brown. The

simple fact is that Deere could not be the multi-billion dollar company they are today without the groundwork laid down by Theo Brown and his Experimental Department. Projects such as the power lift, the 202 tractor, and the GP tractor influenced the designs of today. The general principles of the power take off shafts and power lifts of Theo's days are still seen today. Mechanical shafts have been replaced with hydraulics and gears with pumps but they still operate along the same principles.

Figure 23: Display in the lobby of the John Deere Harvester Works

Theo designed the power primarily to lift implements of the day up and down. It worked by taking power from the motor to raise and lower a draw bar. The draw bar would then raise and lower the implement. Today everything is bigger than it was during Theo's career and thus requires more power to lift. While engine technology did advance quite a ways during the second half of the twentieth century it would be too inefficient to power both a massive tractor and raise and lower a massive implement. A new technology was needed and hydraulics entered the picture. Hydraulics allowed a separate system to be used to raise and lower implements

completely separate from the tractor's engine. Hydraulics is simply the next step from what Theo Brown created in his power lift. Theo's idea was for a mechanical system to raise and lower the implements instead of the farmers themselves. His idea is still seen today just with hydraulics instead of a power lift.

6. Theo Brown: An Engineer's Impact on Society

It's obvious at this point that Theo made a large impact on Deere; however, one can get an even better idea of how big by looking at some of his finance data. Now and then Theo would write down how Deere was doing, both sales and net income wise. Occasionally he would also make note of their competitors. If we look at Figure 24 we see a graph showing both sales and Net Income in Millions of dollars over the years between 1911 and 1938.

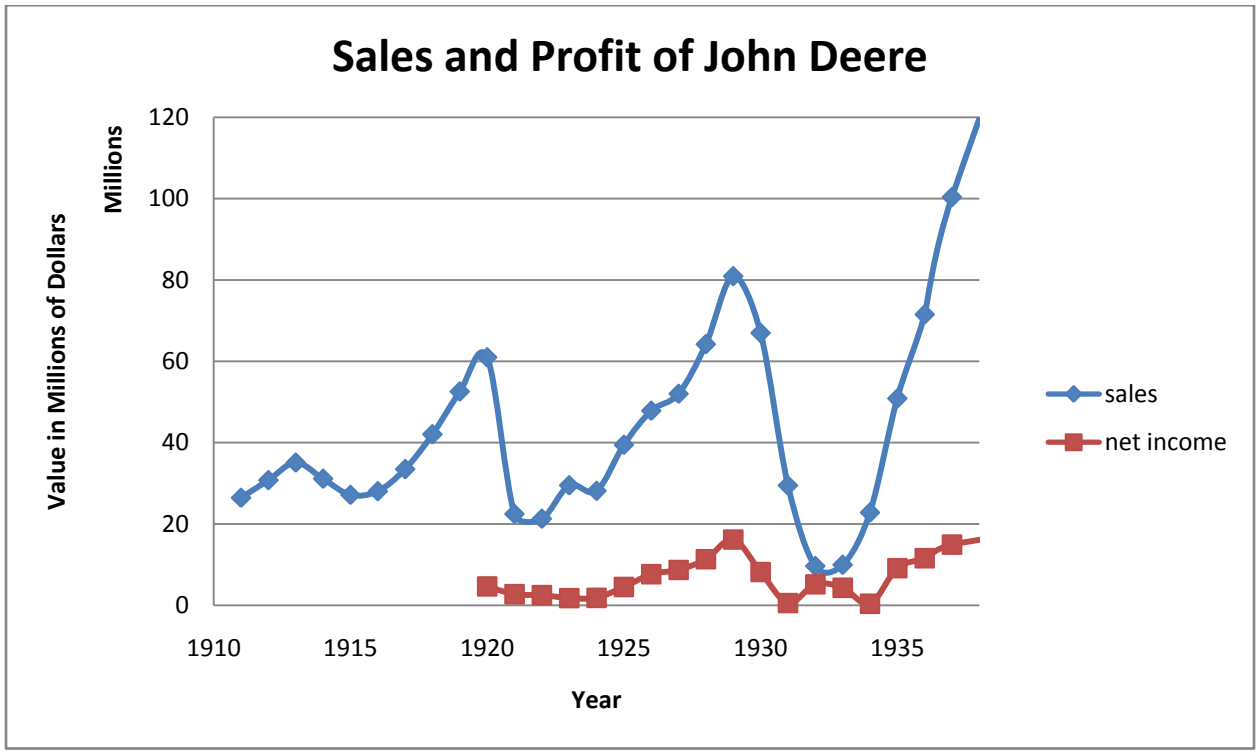


Figure 24: Sales and Profit of John Deere from 1911 to 1938

Looking at the shape of the curve both the great depression and the Agricultural Depression can be seen. While both of these had their impact John Deere, the company did manage to stay profitable. The greatest hit occurred during the great depression. As bad as it was, Deere still made money. This remarkable feat can be attributed to both the quality of products being made by them, and their devotion to innovation. Even during this time Deere continued to fund the experimental department to allow the company to continue to come up with new products and ideas.

This devotion paid off as the graph shows a great leap upward towards the end of the depression. Looking at Figure 25 which shows net profit of both Deere and 4 competitors from 1936 to 1949 we see that Deere made great strides in securing themselves as second in the market.

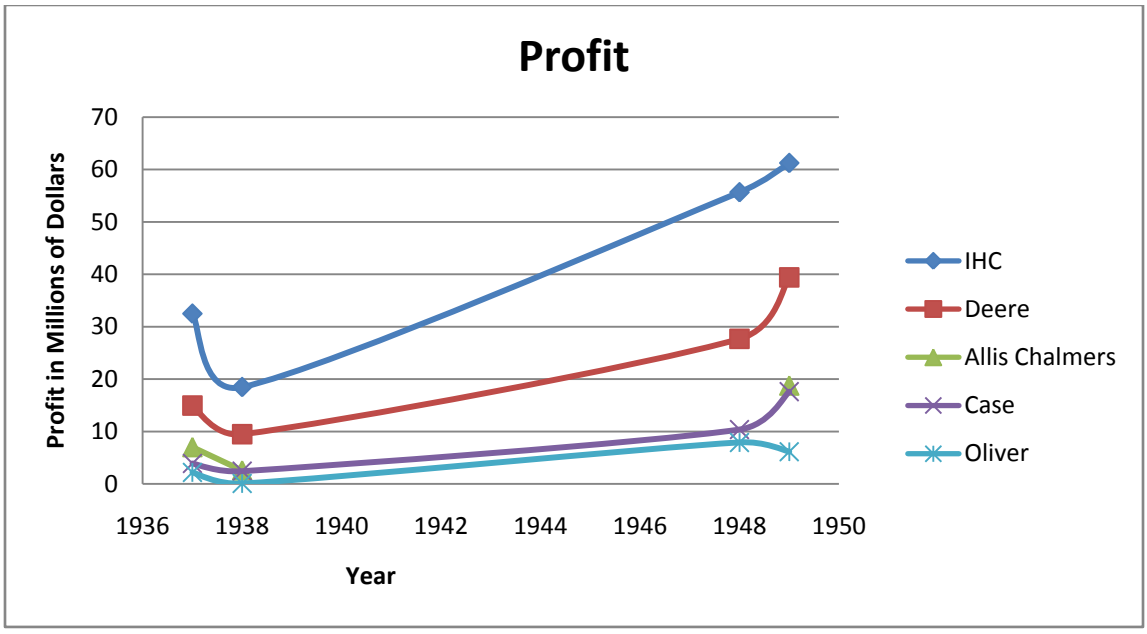


Figure 25: Net Profit of Deere and its competitors

Figure 26 shows sales of the sales of the same companies over the same years. While Deere was still far from IHC, it was producing more profit. This says something about the company, they

were doing a few things right. Their quality products and commitment to the customer allowed them to hold onto their position in the market and eventually become the world leaders after the unfortunate closing of International Harvester.

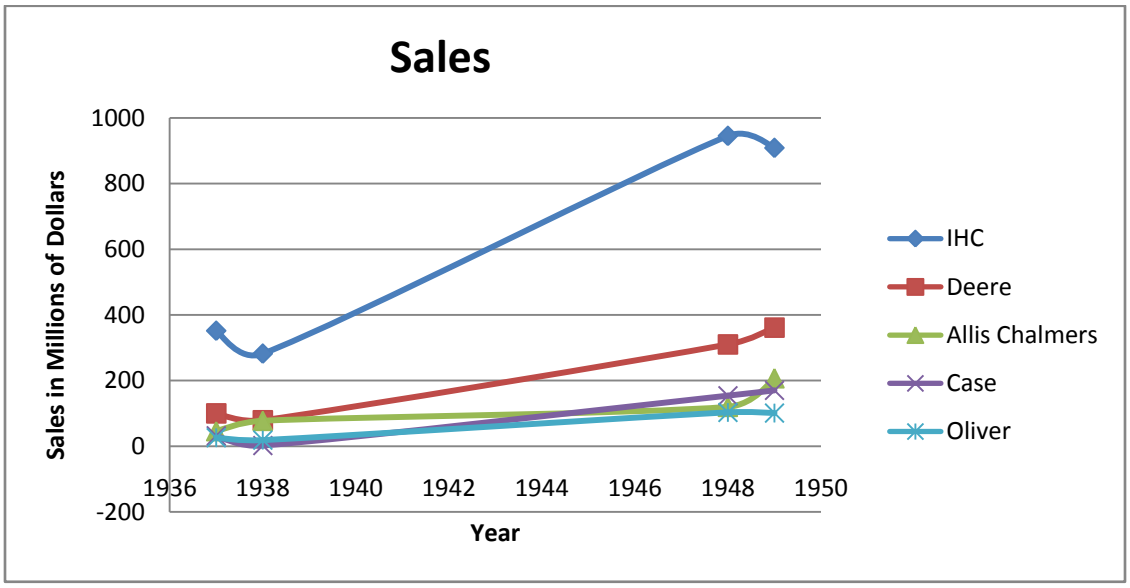


Figure 26: Sales figures for Deere and its competitors

Looking at yet another side it is apparent that Deere was very devoted to innovation. Proof of this comes through patents. While Theo didn't keep very good records of the number of patents that Deere received as a whole he did keep track of his own. Figure 27 shows the number of patents earned by Theo each year from 1904 until 1933. By 1933 he had accumulated 91 patents. He continued this trend, and held 158 patents to his name by the time he retired from Deere.

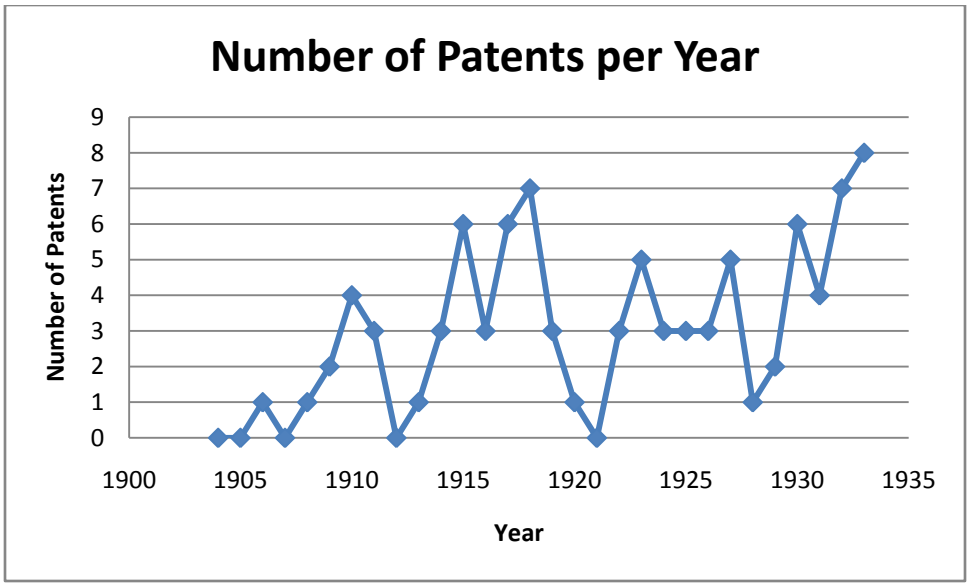


Figure 27: Patents earned per year by Theo Brown

Theo did make mention of the number of patents total by Deere in 1931. John Deere finished the year with 253, which IHC following with 217. Case was the next closest with 83. Looking at these numbers gives an idea as to the development both Theo and John Deere had. New patents meant new products and technologies, which in turn helped the farmer be more productive and efficient.

The first half of the 20th century was an astonishing time for development. In 50 years farmers went from primarily using beasts of burden to primarily tractors. This fact alone had to mean that farmers were producing more. Looking at Figure 28 shows that this is indeed true. The amount each farmer produces increases each year, and not simply at a linear rate either. Starting especially around 1940 an exponential trend is visible.

Drawing from all this data it is apparent that Theo Brown did in fact have a large role within Deere, and Deere's part in progressing innovation the agricultural world.

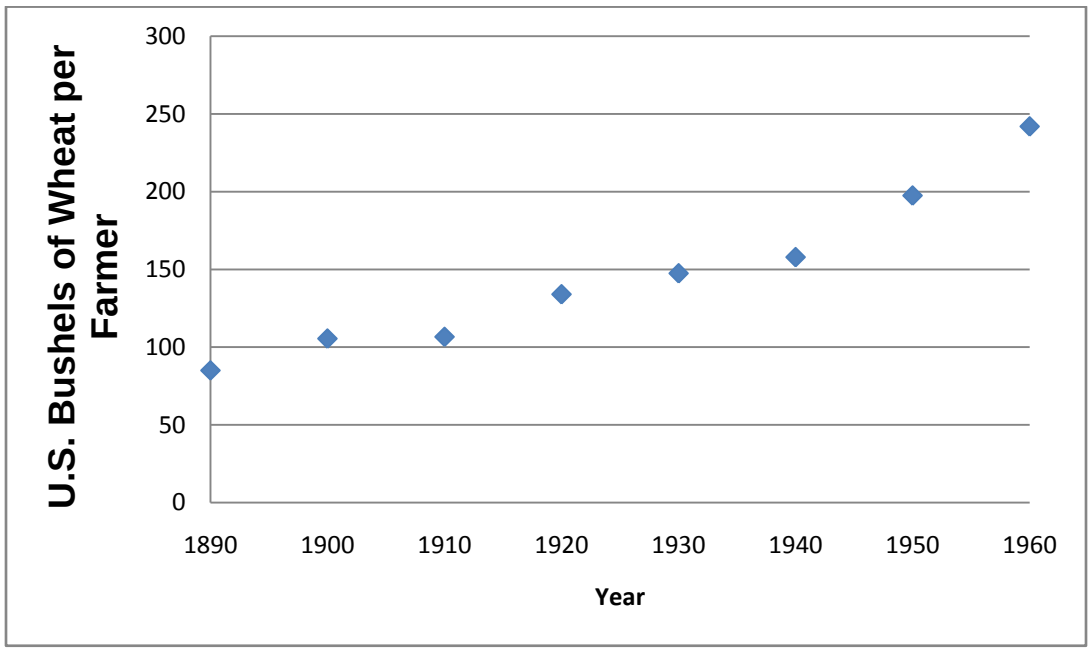


Figure 28: Bushels of Wheat per farmer per year

7. Conclusions

The goal of this project is to determine John Deere and Theo Brown's impact on agriculture and feeding the world. The first half of the 20th century produced huge changes in the way we grow food, to such an extent that it has been called the agricultural revolution. In just under 50 years farms went from primarily using animals to primarily using machines, allowing for large gains in productivity, efficiency, and yield. Looking historically at what happened, Deere's financial history, and Theo's own accomplishments, it can be concluded that both Theo Brown and John Deere were major contributors in changing agriculture and feeding the world.

Recalling the essays written by Malthus, it was predicted that population would grow exponentially, which Figure 29confirms, showing population growth over the past 200 years. Both world and U.S. population grow at an exponential rate, showing a jump around 1950, which happens to be the time that the number of tractors on farms surpassed the number of beasts of burden.

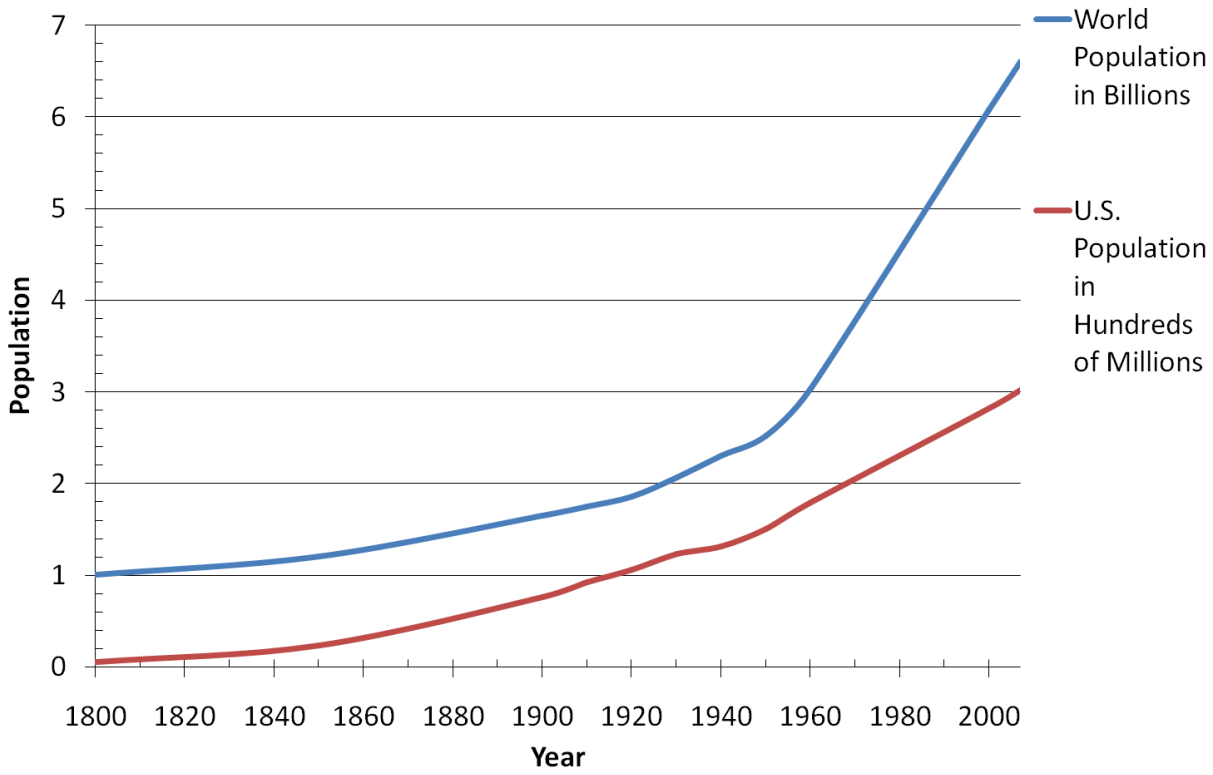


Figure 29: World and US Population

The other part of Malthus's concern was that food production was only going to grow at a linear rate. Looking at Figure 30we see wheat production per farmer per year. While the data up until 1920 appears to be fairly linear, after this point the trend changes, and starts to become more exponential. This happens to be around the time that the tractor was first becoming popular, allowing for farmers to start producing more.

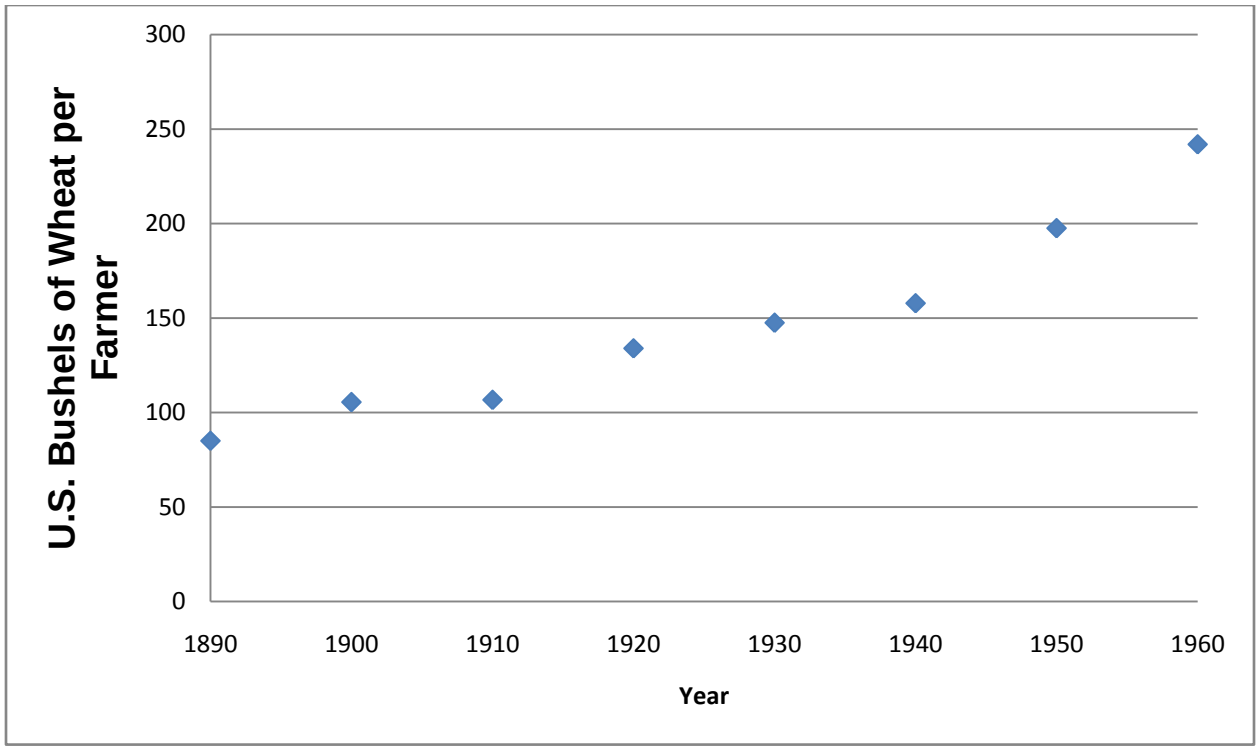


Figure 30: Wheat Produced per Farmer per year

Overlapping these two graphs gives a look at how the trends compare to each other. Figure 31 shows the overlapped trends. The graph shows that not only have food production been able to follow the trends of population, it is almost growing faster. So the conclusion can be made that society has been able to continue feeding itself. But how do John Deere and Theo Brown tie into this success.

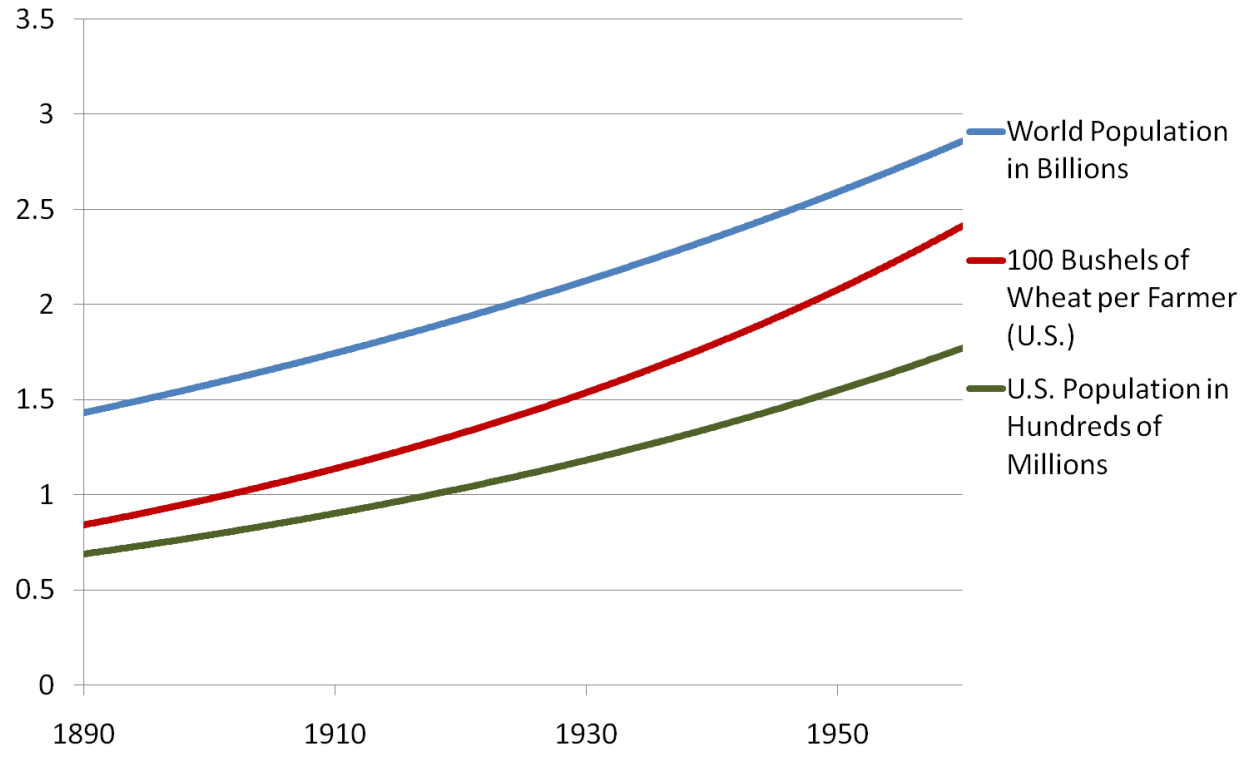


Figure 31: Population and Food Production Trends

John Deere today is the world leader in agricultural equipment, and for the most part have always been major players in the market. Looking at Figure 32 which shows Deere's sales and profit from 1911 through 1933. Even through the agricultural and great depressions they were able to make money. Comparing Deere's Profit to its competitors in Figure 33it is apparent that they are well defined as second in the market. This trend continues until International Harvester's unfortunate bankruptcy when Deere becomes world leaders.

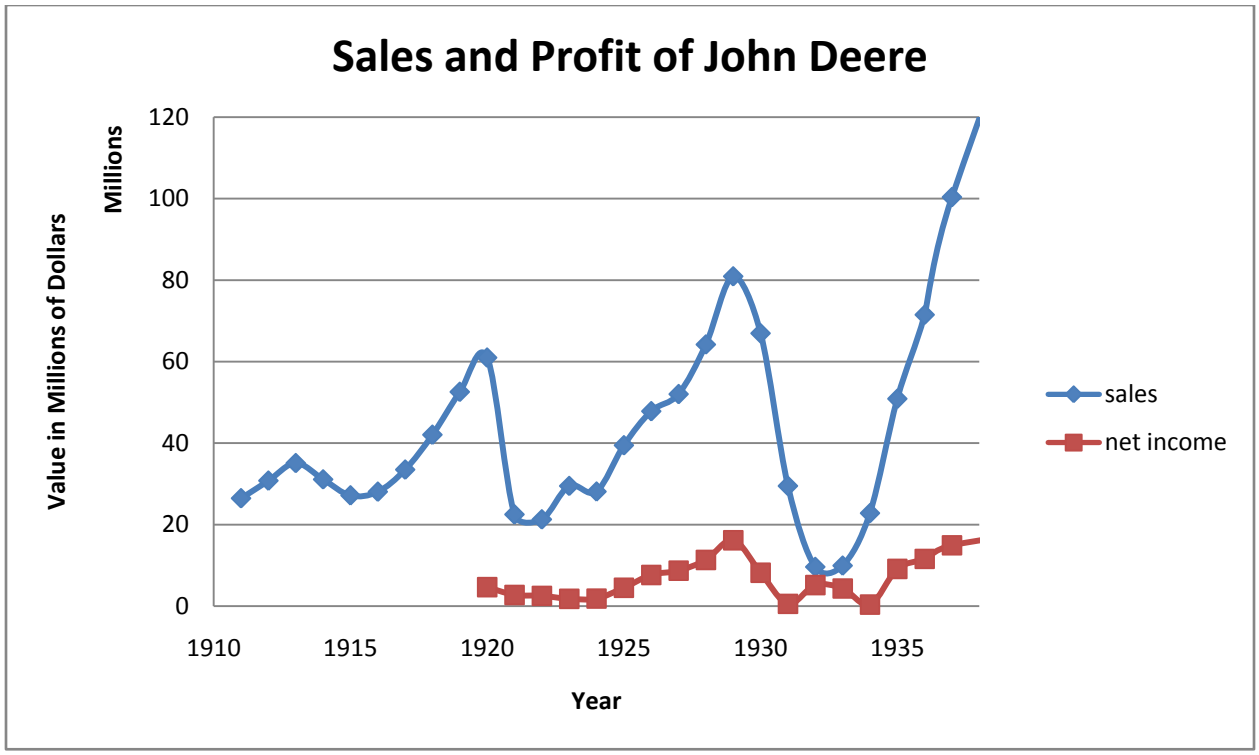


Figure 32: Sales and Profits of John Deere

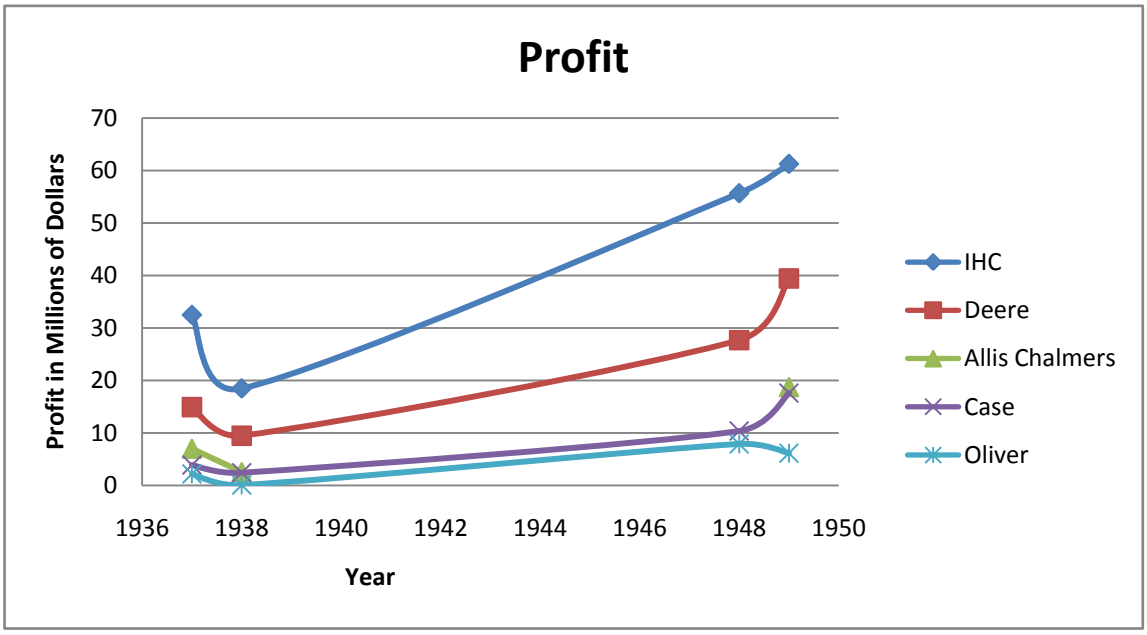


Figure 33: Net Profit of Deere and its Competitors

Another perspective comes with Deere's patents. Always devoted to innovation Deere had huge numbers of patents every year. Even in 1931, while still second in farm equipment sales to IHC, Deere lead them by 36 patents for the year with a total of 253. It was this devotion to always developing the best product that kept Deere moving forward.

This allows the conclusion to be made that Deere was in fact a major contributor to changing and advancing agriculture. It was this changing technology that helped the advancement in food production. This means that Deere was and still is to this day, a very important force in feeding the world.

Knowing that Deere was so important, it can be concluded that Theo was one of the driving forces behind their success. Over his career, Theo received 158 patents, held a seat on the Board of Trustees for nearly 30 years and led the experimental department. Theo had his hand in most of the products coming out of Deere. He was in charge of the entire General Purpose tractor project, and led in designing implements for most tractors following.

Theo also led the way in standardizing IHC's Power Take Off system, and introduced the Power Lift, hailed as one of the top 3 innovations of the decade.[34] He was also very aware of the satisfaction of his customers, and relentlessly sought solutions to any problems. It was this devotion to the company's image, and to the products that they sold that made Theo Brown such an significant part of John Deere. His expertise as an engineer, and attention to detail helped make him as important as he was.

Deere & Co. and Theo Brown have played a substantial role in the effort to feed the world. Theo's countless creative solutions and designs, the many years he devoted to creating the best

possible product and his efforts to back up every product Deere made with personal efforts all contributed greatly to the world leading company that John Deere is today. Without Theo Brown, John Deere would not be the great company it is today and without John Deere, the world would be struggling to keep agriculture growing as population does.

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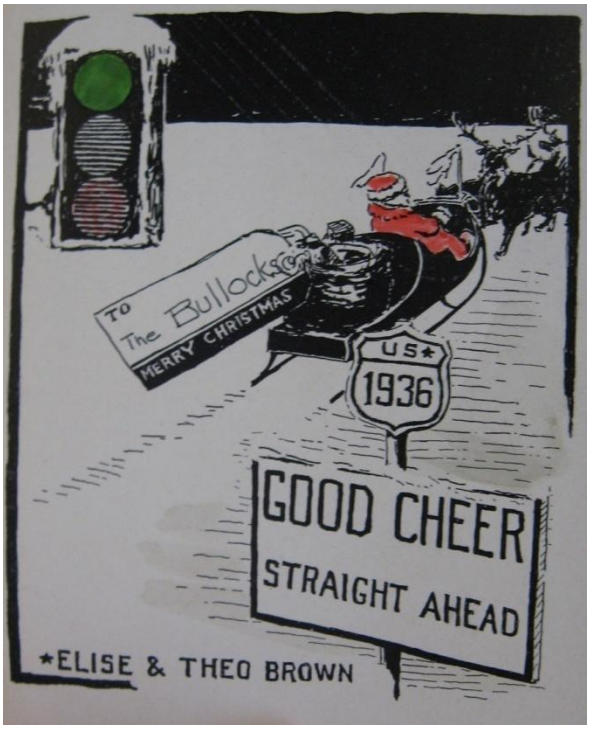
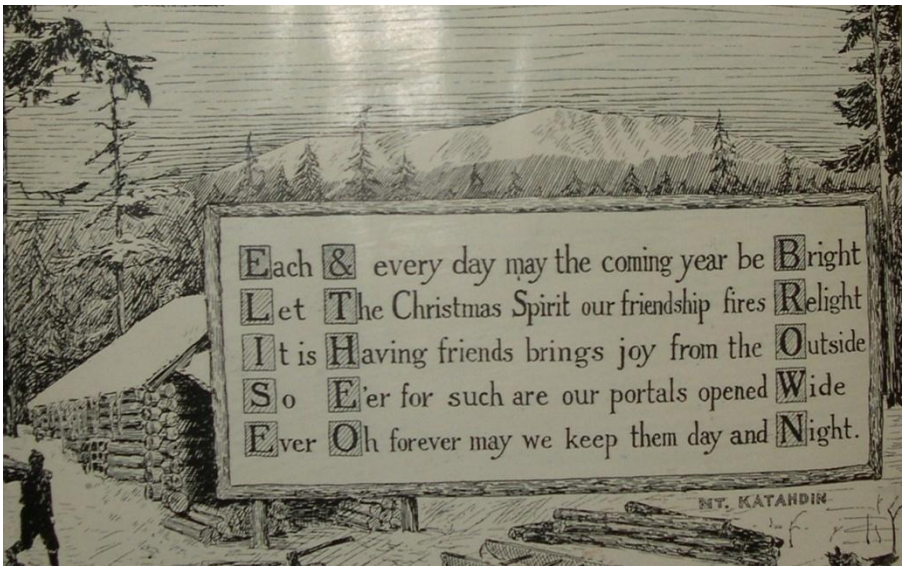
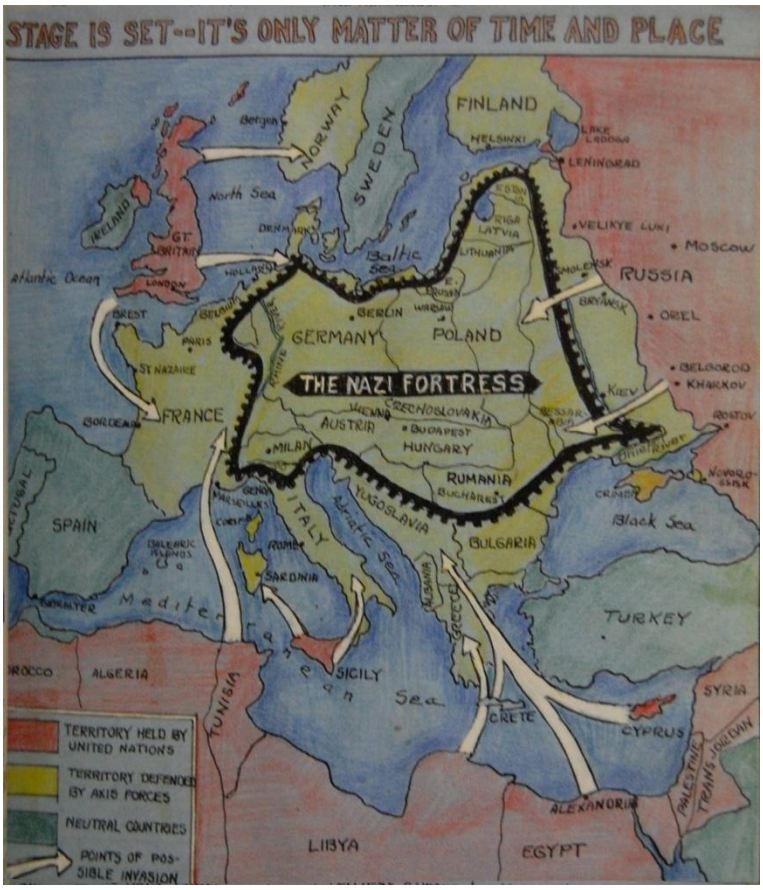
9. Appendix A: Images & Sketches of Theo Brown

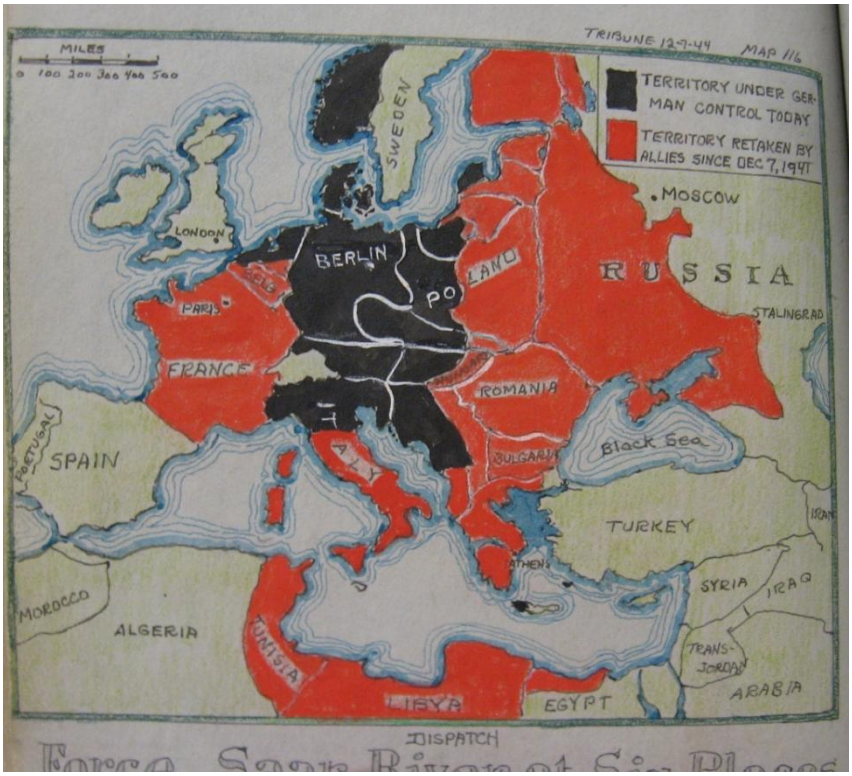

TO
The Bullocks
MERRY CHRISTMAS
US
1936
GOOD CHEER
STRAIGHT AHEAD
*ELISE & THEO BROWN


A VERY MERRY
CHRISTMAS
TO
FROM
ELISE AND THEO BROWN


Each & every day may the coming year be Bright
Let The Christmas Spirit our friendship fires Relight
It is Having friends brings joy from the Outside
So E'er for such are our portals opened Wide
Ever Oh forever may we keep them day and Night.
MT. KATAHDIN


Allied Gains Against Axis in 1943
Green Areas indicate territory won by the Allies in their fight against the axis in Europe and north Africa during 1943. The push up from Africa resulted in Italy's surrender. As 1943 drew to a close, British and American forces were gathering for an attack on Germany from the west. (Associated Press wirephoto.)
0 300 STATUTE MILES
BRITISH ISLES
NORWAY
Bergen
Oslo
FINLAND
SWEDEN
Stockholm
Leningrad
RUSSIA
KAZAN
Rzhev
Moscow
North Sea
DENMARK
Vitebsk
Smolensk
London
Berlin
WARSAW
Zhlobin
Atlantic Ocean
Brest
GERMANY
POLAND
Kiev
Kharkov
Paris
Zhitomir
CZECHOSLOVAKIA
Krivoi Rog
ROSTOV
FRANCE
SWITZ
AUSTRIA
HUNGARY
Odessa
Bordeaux
ITALY
RUMANIA
Novorossisk
Nalchik
PORTUGAL
Bilbao
YUGOSLAVIA
Black Sea
Lisbon
Madrid
Toulon
BULGARIA
SPAIN
Rome
CORSICA
Ankara
GIBRALTER
Naples
TURKEY
SARDINIA
Palermo
GREECE
Casablanca
Oran
Algiers
Bizerte
SICILY
LEVANT STATES
Tunis
MOROCCO
MALTA
Mediterranean Sea
CRETE
CYPRUS
TUNISIA
Tripoli
ALGERIA
Benghazi
Alexandria
Sirte
Suez
AP
LIBYA
EGYPT
ARABIA


STAGE IS SET--IT'S ONLY MATTER OF TIME AND PLACE
FINLAND
NORWAY
SWEDEN
HELSINKI
LENINGRAD
LAKE LADOGA
North Sea
Baltic Sea
Atlantic Ocean
ICELAND
GT BRITAIN
LONDON
DENMARK
HOLLAND
BELGIUM
RIGA LATVIA
LITHUANIA
VELIKIE LUKI
Moscow
SMOLENSK
RUSSIA
BRYANSK
OREL
BEREST
PARIS
BERLIN
WARSAW
GERMANY
POLAND
THE NAZI FORTRESS
ST NAZAIRE
BELGOROD
KHARKOV
KIEV
ROSTOV
FRANCE
BORDEAUX
VIENNA
CZECHOSLOVAKIA
AUSTRIA
BUDAPEST
HUNGARY
MILAN
RUMANIA
BUCHAREST
SEVASTOPOL
CRIMEA
Black Sea
SPAIN
PORTUGAL
BALEARIC ISLANDS
GENOA
MARSEILLES
CORSICA
ROME
ITALY
YUGOSLAVIA
Adriatic Sea
ALBANIA
GREECE
BULGARIA
SARDINIA
Mediterranean Sea
TURKEY
MOROCCO
ALGERIA
TUNISIA
SICILY
CRETE
CYPRUS
SYRIA
PALESTINE
TRANS-JORDAN
ALEXANDRIA
LIBYA
EGYPT
TERRITORY HELD BY UNITED NATIONS
TERRITORY DEFENDED BY AXIS FORCES
NEUTRAL COUNTRIES
POINTS OF POSSIBLE INVASION


TRIBUNE 12-7-44
MAP 116
MILES
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TERRITORY UNDER GERMAN CONTROL TODAY
TERRITORY RETAKEN BY ALLIES SINCE DEC. 7, 1941
SWEDEN
LONDON
BERLIN
POLAND
RUSSIA
Moscow
STALINGRAD
PARIS
FRANCE
ROMANIA
SPAIN
PORTUGAL
ITALY
BULGARIA
Black Sea
TURKEY
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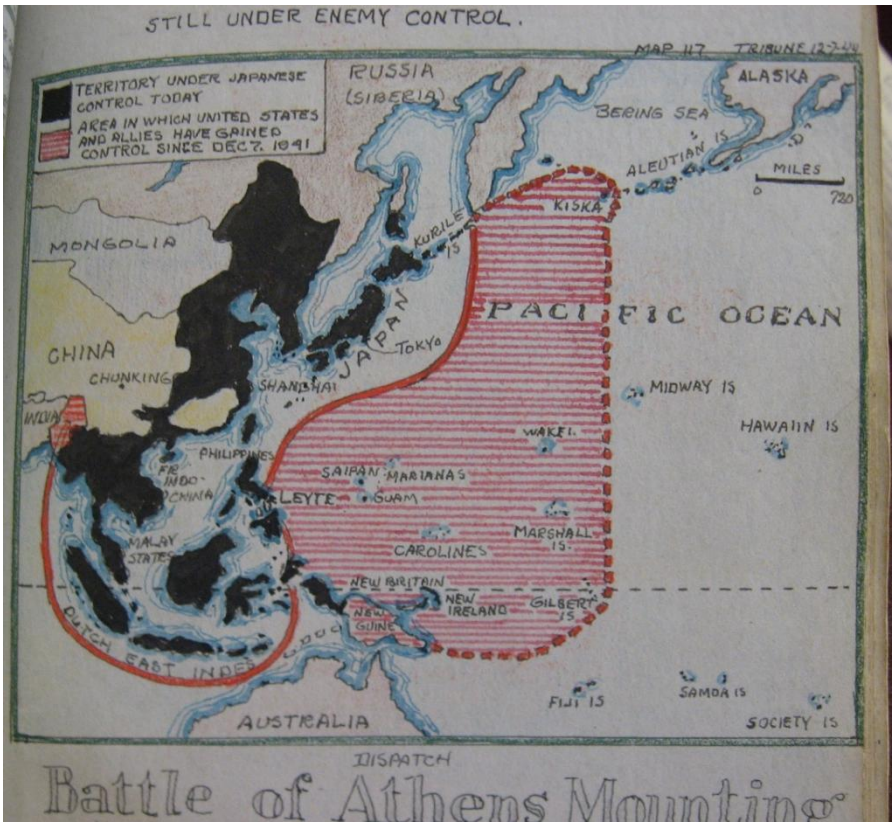
TUNISIA
LIBYA
EGYPT
TRANS-JORDAN
ARABIA
DISPATCH


STILL UNDER ENEMY CONTROL.
MAP 117 TRIBUNE 12-7-44
TERRITORY UNDER JAPANESE CONTROL TODAY
AREA IN WHICH UNITED STATES AND ALLIES HAVE GAINED CONTROL SINCE DEC 7. 1941
RUSSIA (SIBERIA)
ALASKA
BERING SEA
ALEUTIAN IS
MILES
0
720
KISKA
KURILE IS
MONGOLIA
PACIFIC OCEAN
CHINA
JAPAN
TOKYO
CHUNKING
SHANGHAI
MIDWAY IS
HAWAIIN IS
WAKE I.
PHILIPPINES
FR INDO-CHINA
SAIPAN
MARIANAS
LEYTE
GUAM
MALAY STATES
MARSHALL IS.
CAROLINES
NEW BRITAIN
NEW IRELAND
GILBERT IS.
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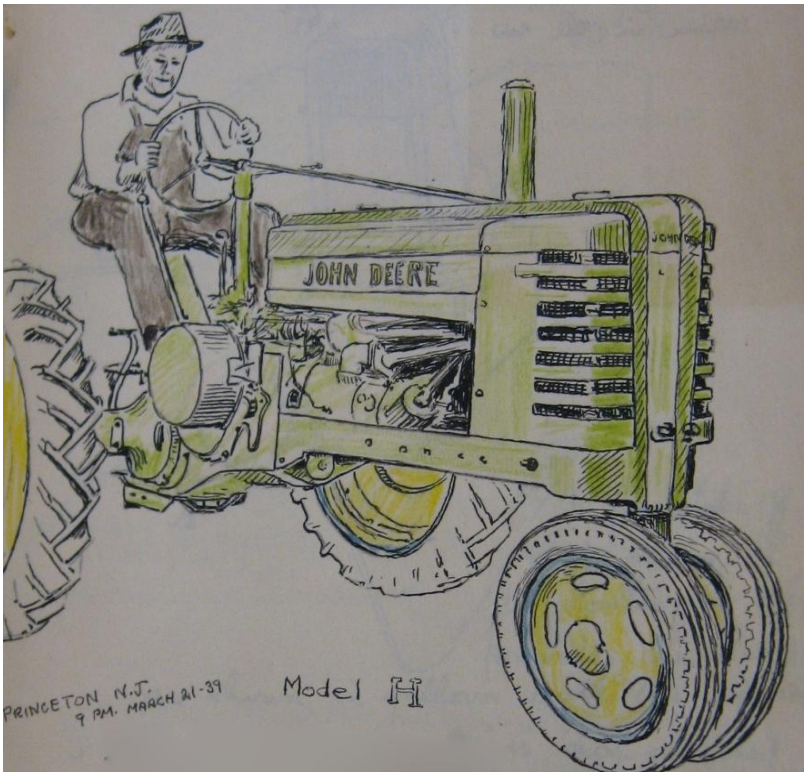
DUTCH EAST INDIES
FIJI IS
SAMOA IS
SOCIETY IS
AUSTRALIA
DISPATCH
Battle of Athens Mounting


JOHN DEERE
PRINCETON N.J.
9 P.M. MARCH 21-39
Model H

[1] William L. Langer, Population Growth and Increase in the means of Subsistence qtd. in David M. Heer, ed. *Readings on Population* (London: Prentice Hall International 1968) 4.

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[20] Randy Leffingwell, *John Deere: A History of the Tractor* (St. Paul: Voyageur Press, 2006) 140-141.

[21] Theophilus Brown, Personal Diary (1939) January 5.

[22] Randy Leffingwell, *John Deere: A History of the Tractor* (St. Paul: Voyageur Press, 2006) 116.

[23] Theophilus Brown, Personal Diary (1928) February 25.

[24] (Brown, 1928, p. Setp 13) Theophilus Brown, Personal Diary (1928) September 13.

[25] Leffingwell, Randy. *John Deere: A History of the Tractor*. St. Paul, MN: Voyageur Press, 2006. 116.

[26] Cole, David. "A History of John Deere Tractors." <http://petcaretips.net/history-john-deere.html>.

[27] Cole, David. "A History of John Deere Tractors." <http://petcaretips.net/history-john-deere.html>.

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[31] "Rummy's John Deere Page." 2/8/2003 2003. Byron Guyer. <http://johnnypopper.com/>.

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